DOCUMENT RESUME

ED 282 045 CE 047 201

TITLE	Idaho Electronics Technology Level One. Curriculum Standards.
INSTITUTION	Idaho State Dept. of Education, Boise. Div. of Vocational Education.
PUB DATE	86
NOTE	211p.
PUB TYPE	Guides - Classroom Use - Guides (For Teachers) (052)
EDRS PRICE	MF01/PC09 Plus Postage.
DESCRIPTORS	Competency Based Education; *Core Curriculum; *Electromechanical Technology; Electronic Control; *Electronic Technicians; Mathematics Skills; Postsecondary Education; State Curriculum Guides; *State Standards; *Statewide Planning; *Technical Education
IDENTIFIERS	*Idaho

ABSTRACT

The curriculum standards for Idaho postsecondary-level electronics technology programs contained in this guide are intended to facilitate the development of a coordinated statewide electronics program that would enable students to transfer from one school to another to specialize in a second- or third-year option not available in the first school. Competencies related to the following areas are described: applied mathematics, electronics theory, electronics laboratory, and electron control devices theory. Although the math competencies are included in a separate unit, science and technical writing competencies are integrated throughout the other units. (MN)

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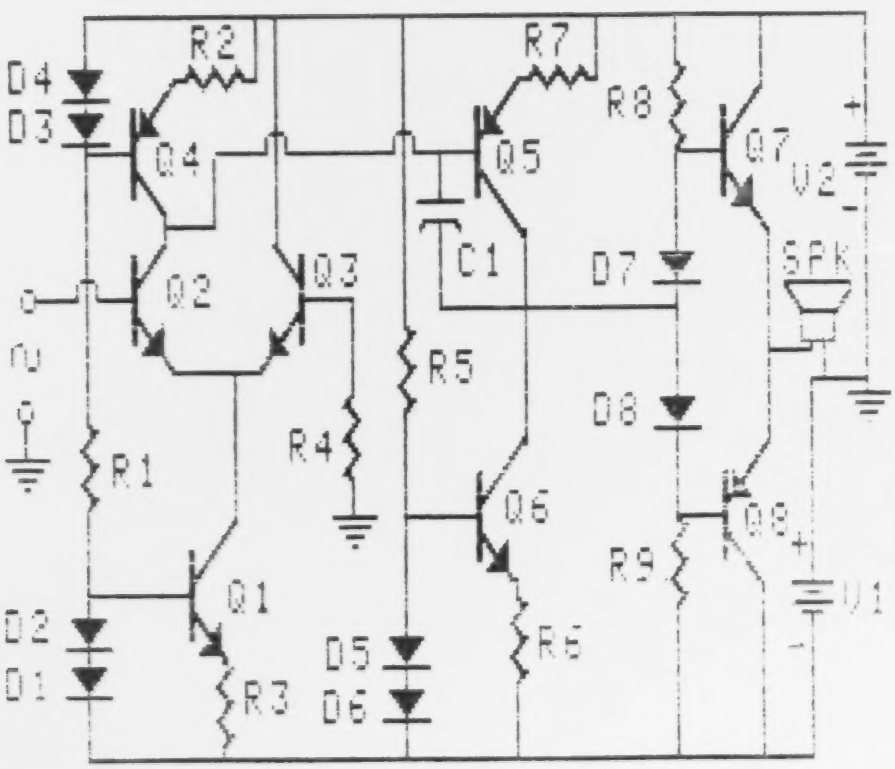
IDAHO ELECTRONICS TECHNOLOGY LEVEL ONE CURRICULUM STANDARDS



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CURRICULUM STANDARDS

FOR

LEVEL ONE ELECTRONICS PROGRAMS

IDAHO DIVISION

OF

VOCATIONAL EDUCATION

1986

ACKNOWLEDGEMENTS

Planning, developing, and writing this publication required the coordinated efforts of many people involved in Vocational-Technical Education in the state of Idaho. Appreciation is expressed to the instructors and administrators who provided technical assistance in the development of this document.

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The Idaho Division of Vocational Education extends thanks to Ben Bartlett (CSI) for the time and work devoted to writing and revising this manual.

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INTRODUCTION

The Idaho Electronics Core Curriculum Project was a cooperative effort among postsecondary instructors and administrators from the six Idaho Area Vocational Schools. The goal was to develop a common core of competency-based standards. This common core would make possible student transfers from one school to another to specialize in a second- or third- year option not available in the first school.

This project was initiated at the direction of the Area School Deans and Directors during fiscal year 1984. The purpose was to develop a coordinated state-wide electronics program which would encourage industrial development in Idaho, especially among those companies needing technicians with an electronics background.

Although there are many different occupations that electronic technicians can specialize in, there exists a common body of knowledge for all these specialties. It is this knowledge which comprises the common core of competency-based program standards included in this manual. These competencies make up the first year of the electronics program at each of Idaho's six Area Vocational-Technical Schools.

Postsecondary electronic programs in Idaho involve two years of instruction with the exception of a third-year option offered at Idaho State University in laser optics. The concept of having a common base of competencies during the first year allows students and employees to enroll in a program close to home during the first year and has the advantage of making available more options to students than could be offered at one school.

This project encompassed three years of activity. First-year electronic instructors met initially and developed the tasks, terminal performance objectives, and enabling objectives for safety, AC/DC, active devices, and related math. During the second year, instructors of second and third year options finalized the common core curriculum standards and an articulation process.

The committee believed it absolutely essential that this document identify what needs to be taught and not how the material should be taught. Therefore, instructors still have the flexibility to use whatever learning style and teaching aids they prefer. To avoid unnecessary duplication of efforts, committee members examined several task listings and electronic curriculum guides, but felt there was little material which was directly adaptable to their needs. As a result, the committee made limited use of task listings and curricula previously developed and started from scratch.

From the beginning the committee made it clear, that if they were going to put a lot of time and effort into this project, the results would be a document they felt was realistic and useful; a document they could support and not one which would sit on a shelf collecting dust. These curriculum standards are such a document. Committee members worked cooperatively sharing ideas, providing information, and determined to complete a useful product.

Although the math competencies are included in a separate unit, it was felt science and technical writing should be part of electronics theory and lab units. Safety is also a separate unit. However, it is recognized that safety must be integrated throughout an electronics program. The committee felt all electronics students should learn cardiopulmonary resuscitation (CPR) but decided this should be left to local discretion.

TASKS
TERMINAL PERFORMANCE OBJECTIVES
COMPETENCIES
AND
ENABLING OBJECTIVES

APPLIED MATHEMATICS I & II

IDAHO STANDARDIZED ELECTRONICS CURRICULUM

PREPARED 13 April, 1985
REVISED 9 December, 1986
BY Electronics Curriculum Committee
Area Vocational Technical Schools
State of Idaho

State of Idaho - Electronics Technology Standardized Vocational Program

PERFORMANCE STANDARDS

The following is a list of measurable performance objectives for the Applied Mathematics I & II portion of the standardized Electronics Technology Program for the State of Idaho Vocational Electronics Curriculum.

This listing is intended to be a simple, easy to read format of the performance standards for this portion of the course. The student, as well as the instructor, can see at a glance the tasks, terminal performance objectives, competencies, and enabling performance objectives that are necessary for completion of this section.

The following list of Conditions and Criteria are intended to be used with each of the Performance Objectives listed later in this document. Where the exact conditions cannot be met, the instructor will be responsible to insure that the purpose of the objective is accomplished. This will guarantee the level of learning necessary for the success of the student.

CONDITIONS:

1. The student may use a calculator, except where specifically prohibited in the objective statement. All simple operations, however, should be performed without the use of a calculator.
2. All answers to mathematical calculations must be accurate to tolerances determined by the instructor.
3. Calculations involving numbers extracted from a graph, must be accurate to tolerances determined by the instructor.
4. The student will be required to list units of measurement, with the numerical answer, when the unit of measurement is an integral part of the answer, such as 5 volts, 1 ampere, 4.7 kilohms.
5. The instructor will insure that the student is exposed to the necessary activities as many times as is needed to insure that the student not only can perform the objective once, but also can retain the knowledge to use it at a later time.
6. It should be understood that although many of the objectives listed appear to be purely mathematical in nature, it is expected that the instructor will confine the instruction to practical applications of the mathematical principals covered, as much as possible.

CRITERIA:

1. All answers must be accurate to within tolerances specified by the instructor, for mathematical solutions, or graphical solutions.
2. Accomplishment of the performance objective may be tested on more than one occasion, through the use of questions on subsequent exams. (Review Questions)
3. Retention of the knowledge of the information covered by the objective may be tested at a later time, by exam items on a final exam, given at the end of the session.

TASKS
PERFORMANCE OBJECTIVES
COMPETENCIES
AND
ENABLING OBJECTIVES

1.1 TASK: Identify and Use the SI System of Measurements

TERMINAL PERFORMANCE OBJECTIVE

1. Convert between the SI system of measurement and the English system of measurement.
2. Express answers obtained using the proper units of measurement and "powers of ten" prefixes as used within the SI system.

COMPETENCIES

1.1.1 COMPETENCY: **Measure quantities in the English system**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to measure quantities in the English measurement system, and list all units of measurement with his/her answers to mathematical problems involving the English system of measurement.

1.1.2 COMPETENCY: **Measure quantities in the SI system**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to measure quantities using the SI system of measurement, and list all units of measurement with his/her answers to mathematical problems involving the SI system of measurement.

1.1.3 COMPETENCY: **Convert from SI to English system**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to convert measurements taken in the SI system of measurement, to units of measurement in the English system of measurement, and list all units of measurement with his/her answers to mathematical problems involving measurement of quantities.

1.1.4 COMPETENCY: **Convert measurements in English system to SI units**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to convert measurements taken in the English system of measurement to equivalent SI units, and list all units of measurement with his/her answers to mathematical problems involving measurement of quantities.

TASKS
PERFORMANCE OBJECTIVES
COMPETENCIES
AND
ENABLING OBJECTIVES

1.2 TASK: Estimate Results and Perform Math Operations Using Powers of Ten

TERMINAL PERFORMANCE OBJECTIVE

1. Perform addition, subtraction, multiplication, and division problems using the correct powers of ten.
2. Express all answers in the proper powers of ten with the appropriate units of measurement included.
3. Use the proper techniques for estimating results, to obtain an approximate answer to math operations.

COMPETENCIES AND EPO'S

1.2.1 COMPETENCY: **Add, subtract, multiply, & divide positive numbers**

ENABLING PERFORMANCE OBJECTIVE
The student will be able to add, subtract, multiply, and divide positive numbers, to obtain the correct results.

1.2.2 COMPETENCY: **Add, subtract, multiply, and divide with signed numbers**

ENABLING PERFORMANCE OBJECTIVE
The student will be able to add, subtract, multiply, or divide with signed numbers, to obtain the correct result. The signs of the numbers obtained for the answer must be listed with the answer, or the answer is wrong.

1.2.3 COMPETENCY: **Converting numbers to powers of ten**

ENABLING PERFORMANCE OBJECTIVE
The student will be able to convert both large and small numbers to powers of ten, or scientific notation. Student will also be able to express the number in engineering notation, for conversion to milli, micro, nano, pico, kilo, mega, etc.

1.2.4 COMPETENCY: **Multiply using powers of ten**

ENABLING PERFORMANCE OBJECTIVE
The student will be able to multiply numbers together, using the appropriate powers of ten, and the rules for multiplying with powers of ten, to obtain the correct result.

1.2.5 COMPETENCY: **Divide using powers of ten**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to divide numbers, using the appropriate powers of ten, and the rules for dividing numbers with powers of ten, to obtain the correct result.

1.2.6 COMPETENCY: **Add using numbers with powers of ten**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to add numbers together, using the appropriate powers of ten, and the rules for adding numbers with powers of ten, to obtain the correct result.

1.2.7 COMPETENCY: **Subtract using powers of ten**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to subtract numbers, using the appropriate powers of ten, and the rules for subtracting numbers with powers of ten, to obtain the correct result.

1.2.8 COMPETENCY: **Add decimal numbers to find approximate answer**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to round off decimal numbers, to the nearest whole number, and add numbers together, without the use of calculator, with an accuracy of 20% or better.

1.2.9 COMPETENCY: **Subtract decimal numbers to find approximate answer**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to round of decimal numbers, to the nearest whole number, and subtract the numbers, without the use of calculator, with an accuracy of 20% or better.

1.2.10 COMPETENCY: **Multiply decimal numbers to obtain approximate result**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to round off decimal numbers and multiply them together, without the use of calculator, with an accuracy of 20% or better.

1.2.11 COMPETENCY: **Division of decimal numbers to obtain approximate result**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to round off decimal numbers, divide them, to obtain an answer accurate to 20%, without the use of calculator.

1.2.12 COMPETENCY: **Find reciprocal of decimal numbers to obtain approximate answer**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to round off decimal numbers, and find the reciprocal of the number, without the use of calculator, with an accuracy of 20% or better.

1.2.13 COMPETENCY: **Find the square of a number to obtain an approximate answer**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to round off decimal numbers and find the square of the number without the use of a calculator, with an accuracy of 20% or better.

1.2.14 COMPETENCY: **Find the square root of decimal numbers to obtain an approximate answer**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to round off decimal numbers and find the square root of the number without the use of a calculator, with an accuracy of 20% or better.

1.2.15 COMPETENCY: **Approximate circuit parameters**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to solve series, parallel, and series parallel combination circuits formulas using the approximation techniques covered in the previous competencies, to obtain 20% accuracy of current, voltage, resistance, and power parameters.

TASKS
PERFORMANCE OBJECTIVES
COMPETENCIES
AND
ENABLING OBJECTIVES

1.3 TASK: Find the reciprocal of any given number

TERMINAL PERFORMANCE OBJECTIVE

Find the reciprocal of any given number, whether integer, whole number, or literal number.

COMPETENCIES AND EPO'S

1.3.1 COMPETENCY: **Find the reciprocal of a whole number**

ENABLING PERFORMANCE OBJECTIVE
The student will be able to find the reciprocal of a whole number. The answer shall be carried out to 3 significant figures.

1.3.2 COMPETENCY: **Find the reciprocal of a decimal number**

ENABLING PERFORMANCE OBJECTIVE
The student will be able to find the reciprocal of a decimal number. The answer shall be carried out to 3 significant figures.

1.3.3 COMPETENCY: **Find the reciprocal of a number expressed as a power of ten**

ENABLING PERFORMANCE OBJECTIVE
The student will be able to find the reciprocal of a number expressed as a power of ten. The answer will be expressed in scientific notation, as well as engineering notation.

1.3.4 COMPETENCY: **Find the reciprocal of a literal number**

ENABLING PERFORMANCE OBJECTIVE
The student will be able to find the reciprocal of a literal number.

1.3.5 COMPETENCY: **Find the reciprocal of a fraction**

ENABLING PERFORMANCE OBJECTIVE
The student will be able to find the reciprocal of fractional number, made up of both standard numbers and literal numbers.

1.3.6 COMPETENCY: **Find the reciprocal of numbers raised to a power**

ENABLING PERFORMANCE OBJECTIVE
The student will be able to find the reciprocal of a number raised to a power,

or fractional numbers raised to a power.

TASKS
PERFORMANCE OBJECTIVES
COMPETENCIES
AND
ENABLING OBJECTIVES

1.4 TASK: Perform Arithmetic Operations on Literal Numbers

TERMINAL PERFORMANCE OBJECTIVE

1. Perform addition, subtraction, multiplication, and division operations on algebraic expressions.
2. Transpose equations; factor; find absolute value; extract the square root; identify and use prime and subscript notation.

COMPETENCIES AND EPO'S

1.4.1 COMPETENCY: **Determine the order of operation**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to determine the proper order of operation of algebraic expressions, to find a correct solution. Brackets and parenthesis will be used to clarify confusing statements.

1.4.2 COMPETENCY: **Factor algebraic expressions**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to factor, transpose, and solve each term in a given formula. The student will recognize and use prime factors, coefficients, and non prime factors.

1.4.3 COMPETENCY: **Find the square root of a number**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to extract the square root of a number, whether standard or literal number, and check the result by finding the square of the answer obtained.

1.4.4 COMPETENCY: **Find the absolute value of a number**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to find the absolute value of a number.

1.4.5 COMPETENCY: **Add polynomial expressions**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to add polynomial expressions to obtain the correct result.

1.4.6 COMPETENCY: **Subtract polynomial expressions**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to subtract polynomial expressions, to obtain the correct result.

1.4.7 COMPETENCY: **Multiply polynomials by monomials**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to multiply polynomial expressions by monomial expressions, to obtain the correct results.

1.4.8 COMPETENCY: **Multiply polynomials by polynomials**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to multiply polynomial expressions by other polynomial expressions to obtain the correct answer.

1.4.9 COMPETENCY: **Division of a polynomial by a monomial**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to divide a polynomial expression by monomial expression to obtain the correct result.

1.4.10 COMPETENCY: **Divide a polynomial by a polynomial**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to divide a polynomial expression by another polynomial expression, to obtain the correct result.

TASKS
PERFORMANCE OBJECTIVES
COMPETENCIES
AND
ENABLING OBJECTIVES

1.5 TASK: Solve Algebraic Equations, Using Grouping, Arithmetic Operations, Factoring, and Other Simplification Techniques

TERMINAL PERFORMANCE OBJECTIVE

1. Simplify expressions involving integer exponents.
2. Simplify expressions involving fractional exponents.
3. Simplify radical expressions after conversion to exponent form.
4. Simplify algegraic expressions by removing grouping symbols.
5. Simplify algebraic expressions through the use of addition and subtraction techniques.
6. Simplify algebraic expressions through the use of multiplication and division.
7. Simplify algebraic expressions through the use of factoring methods.

COMPETENCIES AND EPO'S

1.5.1 COMPETENCY: **Cancelling terms in an equation**

ENABLING PERFORMANCE OBJECTIVE
The student will be able to cancel terms in an algebraic equation, using the correct axioms, postulates, and laws of math.

1.5.2 COMPETENCY: **Changing signs in an equation**

ENABLING PERFORMANCE OBJECTIVE
The student will be able to change the signs of operation on both sides of an algebraic equation, without changing the value of the equation.

1.5.3 COMPETENCY: **Checking the solution of an algebra problem**

ENABLING PERFORMANCE OBJECTIVE
The student will be able to check the results of a problem by using the laws of math to test the results obtained.

1.5.4 COMPETENCY: **Determine the ratio between two quantities**

ENABLING PERFORMANCE OBJECTIVE
The student will be able to compare two quantities, determine the ratio between the two quantities, and write that ratio as a correctly stated ratio formula.

1.5.5 COMPETENCY: **Determining proportionality of quantities**

ENABLING PERFORMANCE OBJECTIVES

The student will be able to express as a proportion, any given albebraic formula.

1.5.6 COMPETENCY: **Calculate highest common factor.**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to define the term 'highest common factor', and calculate the highest common factor for any given set of numbers.

1.5.7 COMPETENCY: **Calculate lowest common multiple**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to define the terms 'multiple' and 'lowest common multiple' and be able to calculate the lowest common multiple for any given set of numbers.

1.5.8 COMPETENCY: **Reduce fractions to lowest terms**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to reduce fractions to their lowest terms, using factoring of the numerator and denominator into prime factors and cancelling common fractions.

1.5.9 COMPETENCY: **Changing signs of a fraction**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to determine the sign of a fractional expression, and be able to change the signs of the terms in the expression, or the sign of the expression, without changing the value of the fractional expression.

1.5.10 COMPETENCY: **Find lowest common denominator**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to determine the lowest common denominator of two or more fractional expressions, and convert all of the expressions to equivalent fractions using the lowest common denominator.

1.5.11 COMPETENCY: **Convert fractions to decimal numbers**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to convert fractions to decimal numbers, accurate to three significant figures, using division of the denominator into the numerator method.

1.5.12 COMPETENCY: **Change mixed expressions to fractional equivalent**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to change mixed expressions to fractional expressions, to express mixed expressions as improper fractions.

1.5.13 COMPETENCY: **Convert improper fractions to mixed expressions**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to convert improper fractions to mixed expressions, and reduce the result to lowest terms.

1.5.14 COMPETENCY: **Solve fractional equations**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to perform common math operations on fractional expressions, such as addition, subtraction, multiplication, division, square root, square, reciprocal, etc., to solve fractional equations for one unknown, and be able to transpose fractional equations to solve for all unknowns in the equation.

1.5.15 COMPETENCY: **Use laws of exponents to solve multiplication problems.**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to use the laws of exponents to simplify multiplication problems, of the form $x^a/x^b=x^{a-b}$.

1.6.16 COMPETENCY: **Use laws of exponents to solve division problems**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to use the laws of exponents to simplify division problems, of the form x^a/x^b+x^{a-b}.

1.5.17 COMPETENCY: **Determine the value of the zero exponent**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to determine the value of a number, when raised to the zero power.

1.5.18 COMPETENCY: **Determine the value of numbers with negative exponents**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to determine the value of a literal or standard number, when raised to a negative power, and use negative exponents in multiplication, division, addition, and subtraction.

1.5.19 COMPETENCY: **Determine the value of numbers with fractional exponents.**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to rewrite numbers with fractional exponents in radical form, and determine the value of the standard numbers.

1.5.20 COMPETENCY: **Convert radical expressions to exponent**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to convert radical expressions to exponent form, and simplify expressions containing radical expressions.

1.5.21 COMPETENCY: **Simplify radical expressions containing fractions**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to simplify radical expressions containing fractional expressions, to obtain the correct answer.

1.5.22 COMPETENCY: **Simplify expressions containing terms with powers raised to other powers**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to simplify expressions containing terms with powers raised to other powers, to obtain the correct answer.

1.5.23 COMPETENCY: **Perform math operations with numbers contained in parenthesis, or brackets**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to add, subtract, multiply, or divide using numbers contained within signs of grouping, such as parenthesis, or brackets; student will be able to change the signs of terms within the grouping, without changing the value of the terms, and expand the grouped expression so the signs of grouping may be omitted.

1.5.24 COMPETENCY: **Using addition axiom to simplify algebra expressions**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to add numbers to the left and right members of algebra equations, to transpose the equation, or allow for solution of the equation for the unknown quantity.

1.5.25 COMPETENCY: **Using subtraction axiom to simplify algebra expressions**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to subtract numbers from the left and right members of algebra equations, to transpose the equation, or allow for solution of the equation for the unknown quantity.

1.5.26 COMPETENCY: **Using multiplication axiom to simplify algebra expressions**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to multiply numbers to the left and right members of

algebra equations, to transpose the equation, or allow for solution of the equation for the unknown quantity.

1.5.27 COMPETENCY: **Using division axiom to simplify algebra expressions**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to divide numbers on the left and right members of algebra equations, to transpose the equation, or allow for solution of the equation for the unknown quantity.

1.5.28 COMPETENCY: **Using square root axiom to simplify algebra expressions**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to extract the square root of terms in the left and right members of algebra equations, to transpose the equation, or allow for solution of the equation for the unknown quantity.

1.5.29 COMPETENCY: **Using squaring axiom to simplify algebra expressions**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to square the terms in the left and right members of algebra equations, to transpose the equation, or allow for solution of the equation for the unknown quantity.

1.5.30 COMPETENCY: **Using reciprocal axiom to simplify algebra expressions**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to take the reciprocal of the terms in the right and left members of algebra equations, to transpose the equation, or allow for solution of the equation for the unknown quantity.

1.5.31 COMPETENCY: **Using substitution to simplify algebra expressions**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to substitute equal quantities into an algebra equation, to transpose the equation, or to allow for solution of the equation for the unknown quantity.

1.5.32 COMPETENCY: **Using factoring to simplify algebra**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to factor algebraic equations, to allow for transposition of the equation, or to allow for solution of the equation for the unknown quantity.

TASKS
PERFORMANCE OBJECTIVES
COMPETENCIES
AND
ENABLING OBJECTIVES

1.6 TASK: Solve Linear and Quadratic Equations for All Variables

TERMINAL PERFORMANCE OBJECTIVE

1. Solve Linear Algebraic equations in one or two variables.
2. Solve quadratic equations through factoring, completion of square, and quadratic formula.
3. Solve algebraic equations in quadratic form, graphing the results.

COMPETENCIES AND EPO'S

1.6.1 COMPETENCY: **Develop formulas from descriptions of practical problems**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to read through a description of a situation, determine what information is needed for solution of the problem, express that information in the correct form and the proper mathematical relationship for solution, and solve the expression for the necessary unknown value.

1.6.2 COMPETENCY: **Solve simultaneous linear equations by using graphs**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to solve simultaneous linear equations for two variables, using graphical analysis of the equations, and determining their common values.

1.6.3 COMPETENCY: **Solve simultaneous linear equations by using addition and subtraction**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to solve simultaneous linear equations for two variables, using addition and subtraction techniques.

1.6.4 COMPETENCY: **Solve linear equations by using substitution**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to solve simultaneous linear equations for two variables, using the technique of substitution of quantities.

1.6.5 COMPETENCY: **Solve linear equations by using comparison**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to solve simultaneous linear equations for two variables, using the technique of comparison.

1.6.6 COMPETENCY: **Solve quadratic equations using factoring, completing the square, and the quadratic formula**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to find the root of a quadratic equation, using factoring method, completing the square method, and quadratic formula.

1.6.7 COMPETENCY: **Graph results of quadratic equations**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to draw a graph, depicting the results of the solution of a quadratic equation, on rectangular graph paper.

1.6.8 COMPETENCY: **Determine maxima or minima values**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to examine the graph of a quadratic equation, and determine the maxima or minima values for the graph, using rectangular graph paper.

TASKS
PERFORMANCE OBJECTIVES
COMPETENCIES
AND
ENABLING OBJECTIVES

1.7 TASK: Plot Functions Using the Rectangular Coordinate System

TERMINAL PERFORMANCE OBJECTIVE

1. Define and identify the function of each dependent and independent variable and give its qualifications.
2. Derive functions from physical data and/or combinations of standard formulas.
3. Plot functions using the rectangular coordinate system, for both linear and non-linear functions.

COMPETENCIES AND EPO'S

1.7.1 COMPETENCY: **Define dependent and independent variable**

ENABLING PERFORMANCE OBJECTIVE
The student will be able to define the terms 'dependent variable', and 'independent variable' and give the qualifications of each.

1.7.2 COMPETENCY: **Locate points on a graph**

ENABLING PERFORMANCE OBJECTIVE
The student will be able to locate points on a rectangular graph, given the x and y values or coordinates.

1.7.3 COMPETENCY: **Plot linear and non-linear equations**

ENABLING PERFORMANCE OBJECTIVE
The student will be able to insert the necessary values for the independent variable, solve the equation for the dependent variable, and plot the results on rectangular graph paper, for any linear or non-linear equation.

1.7.4 COMPETENCY: **Derive and plot data gained from practical problems**

ENABLING PERFORMANCE OBJECTIVE
The student will be able to extract the necessary data from a description of a problem, determine what information is relevant to solution of the problem, express that information in the correct form and in the correct format for mathematical solution, and solve the problem.

TASKS
PERFORMANCE OBJECTIVES
COMPETENCIES
AND
ENABLING OBJECTIVES

1.8 TASK: Solve Logarithmic Expressions and Equations

TERMINAL PERFORMANCE OBJECTIVE

1. Identify and make use of the properties of logarithms and exponentials.
2. Explain the differences between common logs and natural logs.
3. Identify logarithmic expressions of the form $y=\log_b x$.
4. Identify exponential expressions of the form $y=b^x$.
5. Derive and plot data gained from practical problems.

COMPETENCIES AND EPO'S

1.8.1 COMPETENCY: **Define logarithm**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to define the meaning of the term 'logarithm', and give examples of logarithms.

1.8.2 COMPETENCY: **Define natural logarithm**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to define the meaning of the term 'natural logarithm' and give examples of natural logarithms.

1.8.3 COMPETENCY: **Define common logarithm**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to define the meaning of the term 'common logarithm', give examples of common logarithms, and explain the difference between natural and common logarithms.

1.8.4 COMPETENCY: **Identify log expression**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to identify a logarithmic expression, and write logarithmic expressions of the form $y=\log_b x$.

1.8.5 COMPETENCY: **Define antilog**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to define the term antilog and give examples of an antilog.

1.8.6 COMPETENCY: **Define mantissa and characteristic**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to define the terms 'mantissa' and 'characteristic', and give examples of each as related to logarithms.

1.8.7 COMPETENCY: **Find log of a product**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to find the logarithm of the product of two terms containing logarithms, using the rules for logarithms of products.

1.8.8 COMPETENCY: **Find log of a quotient**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to find the logarithm of the quotient of two terms containing logarithms, using the rules for logarithms of quotients.

1.8.9 COMPETENCY: **Find log of a power**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to find the logarithm of a term containing a logarithm which has been raised to a power, using the rules for logarithms of powers.

1.8.10 COMPETENCY: **Find log of a root**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to find the logarithm of the root of a term containing a logarithm, using the rules for logarithms of a root.

1.8.11 COMPETENCY: **Derive and plot data gained from practical problems**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to read the description of a problem, determine what information is necessary for the solution of the problem, arrange that information in the correct form for mathematical solution in logarithmic form, to solve the equation containing logarithmic expressions for the unknown values.

1.8.12 COMPETENCY: **Solve voltage db problems**

ENABLING PERFORMANCE OBJECTIVES

The student will be able to solve for the ratio between two voltages, in decibels. Student will also be able to find the unknown voltage when given the number of decibels and one of the voltages.

1.8.13 COMPETENCY: **Solve current db problems**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to solve for the ratio of two current values, in decibels. Student will also be able to solve for the unknown value of current, when given the number of decibels, and one of the current values.

1.8.14 COMPETENCY: **Solve db problems related to power**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to solve for the ratio of two power values in decibels. Student will also be able to solve for the unknown value of power, when given the number of decibels and one of the power values.

1.8.15 COMPETENCY: **Solve db problems using fixed reference voltage**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to solve db problems relating to a fixed reference voltage, such as Odb=1000 microvolts, to determine voltage levels, when given the reference level, and the number of db.

1.8.16 COMPETENCY: **Solve db problems using fixed reference power**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to solve db problems relating to a fixed reference power, such as Odb=1 milliwatt, to determine power level, when given the reference level, and the number of db.

TASKS
PERFORMANCE OBJECTIVES
COMPETENCIES
AND
ENABLING OBJECTIVES

1.9 TASK: Express Angles in Decimal Degrees and Radians.

TERMINAL PERFORMANCE OBJECTIVE

1. **Express any given angle in decimal degrees.**
2. **Express any given angle in radians.**
3. **Convert from one form to another.**

COMPETENCIES AND EPO'S

1.9.1 COMPETENCY: **Express angles in decimal degrees**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to measure an angle with a protractor, and express that angle in decimal degrees, with answers carried out to three significant figures.

1.9.2 COMPETENCY: **Express angles in radians**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to determine the magnitude of any angle in the four quadrants, and express that angle in radians, with answers carried out to three significant factors.

1.9.3 COMPETENCY: **Convert decimal degrees to radians**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to convert measurements in decimal degrees to radians, with answers carried out to three significant figures.

1.9.4 COMPETENCY: **Convert radians to decimal degrees**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to convert measurements in radians to decimal degrees, with answers carried out to three significant figures.

TASKS
PERFORMANCE OBJECTIVES
COMPETENCIES
AND
ENABLING OBJECTIVES

1.10 TASK: Describe the Relationship of Trigonometric Functions to the Right Triangle

TERMINAL PERFORMANCE OBJECTIVE

1. Define the sine, cosine, and tangent, of an angle.
2. Show the relationship of length of sides to the three trigonometric functions of the right triangle and show how each is affected as side length is changed.
3. Give the sign (+ or -) of each of the three trig functions in the four quadrants.
4. Calculate the distance between two points, by using the distance formula.
5. Given two points on the specified line, and/or the line's slope and one point on the line and/or the line's slope and the y intercept, use the laws, proofs, and theorems of Plane Geometry to find the equation for a straight line.

COMPETENCIES AND EPO'S

1.10.1 COMPETENCY: **Define sine, cosine, and tangent**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to define the terms 'sine', cosine', and 'tangent', in terms of the relationship of sides of a right triangle to each other, or select the correct definition from a list of possible choices concerning trig terms.

1.10.2 COMPETENCY: **Calculate sine**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to calculate the sine of an angle, when given the necessary information concerning the sides of a right triangle, and determine the size of the angle from this information.

1.10.3 COMPETENCY: **Calculate cosine**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to calculate the cosine of an angle, when given the necessary information concerning the sides of a right triangle, and determine the size of the angle from this information.

1.10.4 COMPETENCY: **Calculate tangent**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to calculate the tangent of an angle, when given the necessary information concerning the sides of a right triangle, and determine the size of the angle from this information.

1.10.5 COMPETENCY: **Determine sign of trig function**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to determine the sign of the sine, cosine, and tangent functions for angles in any of the four quadrants.

1.10.6 COMPETENCY: **Define x axis, y axis, and slope of a line**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to define the terms 'x axis', 'y axis', and 'slope of a line', as related to solving equations by using graphical means.

1.10.7 COMPETENCY: **Graphically solve linear equations**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to solve linear equations by using graphs to plot the values of the dependent variable, and independent variable, for enough different quantities to determine the solutions to the equation, the Y intercept, and the slope of the line.

1.10.8 COMPETENCY: **Find the slope of the line**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to calculate the slope of the line for a linear equation, by using the proofs, laws, and theorems of Plane Geometry.

1.10.9 COMPETENCY: **Find equation for straight line**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to find the equation for a straight line, when given either the line slope and one point on the line, or the line's slope and the y intercept.

1.10.10 COMPETENCY: **Define angle of elevation**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to define the term 'angle of elevation' as it relates to determining horizontal distance, and explain the effect angle of elevation has on distance measurements.

1.10.11 COMPETENCY: **Define angle of depression**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to define the term 'angle of depression'as it relates to determining horizontal distance, and explain the effect angle of depression

has on distance measurements.

1.10.12 COMPETENCY: **Define horizontal and vertical distance**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to define the terms 'horizontal distance', and 'vertical distance', and explain the difference between them.

1.10.13 COMPETENCY: **Define rise and fall**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to define the terms 'rise' and 'fall', as they relate to the measurement of distance.

1.10.14 COMPETENCY: **Define run, slope, and grade**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to define the terms 'run', slope', and 'grade', and explain how they relate to the measurement of distance.

1.10.15 COMPETENCY: **Solve for the distance between 2 points**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to solve for the distance between two points, for horizontal and vertical distance problems, including problems involving angles of elevation and angles of depression.

TASKS
PERFORMANCE OBJECTIVES
COMPETENCIES
AND
ENABLING OBJECTIVES

1.11 TASK: Use the Laws of Sines and Cosines to Find Angles and Sides of Oblique Triangles.

TERMINAL PERFORMANCE OBJECTIVE

1. Solve for the unknown sides and/or angles in oblique triangles using the law of sines.
2. Solve for the unknown sides and/or angles in oblique triangles using the law of cosines.

COMPETENCIES AND EPO'S

1.11.1 COMPETENCY: **Describe tangent identity in terms of sine and cosine**

ENABLING PERFORMANCE OBJECTIVE
The student will be able to describe the tangent identity in terms of sine and cosine function, and write this identity as a formula.

1.11.2 COMPETENCY: **Describe Pythagorean identity using sine and cosine**

ENABLING PERFORMANCE OBJECTIVE
The student will be able to describe the Pythagorean identity in terms of sine and cosine functions, and write this identity as a formula.

1.11.3 COMPETENCY: **Convert oblique triangle into right triangles**

ENABLING PERFORMANCE OBJECTIVE
The student will be able to convert an oblique triangle into 2 right triangles, by using a perpendicular altitude divider, and solve for the sides and angles in the 2 right triangles and in the oblique triangle.

1.11.4 COMPETENCY: **Use the law of sines to find angles and sides of oblique triangles**

ENABLING PERFORMANCE OBJECTIVE
The student will be able to use the law of sines, when given two of the sides and the angle opposite one of the sides, to solve for the values of the sides and angles in an oblique triangle.

1.11.5 COMPETENCY: **Use the law of cosines to find angles and sides of oblique triangles**

ENABLING PERFORMANCE OBJECTIVE
The student will be able to use the law of cosines, when given two of the sides, and the angle between the two sides, to solve for the values of the

angles and sides of the oblique triangle.

1.11.6 COMPETENCY: **Solve practical problems using laws of sines, laws of cosines, and general trig functions**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to solve practical problems involving triangles, by using the laws of sine and cosine, as well as general trigonometric functions and identities. It will be up to the student to read through the description of the problem, decide what information is necessary for solution of the problem, and solve the problem to find the values of sides and angles of triangles.

TASKS
PERFORMANCE OBJECTIVES
COMPETENCIES
AND
ENABLING OBJECTIVES

1.12 TASK: Perform Mathematical Analysis of Angular Voltages

TERMINAL PERFORMANCE OBJECTIVE

1. Given the value of maximum voltage, time, and frequency, calculate instantaneous values of voltage.
2. Transpose the formula for instantaneous values of voltage to solve for the other unknown values.

COMPETENCIES AND EPO'S

1.12.1 COMPETENCY: **Identify formula for instantaneous values of voltage and current**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to identify the formula to solve for instantaneous values of voltage and current in the AC sine wave, by selecting the correct formula from a list of possible choices concerning AC voltages and currents.

1.12.2 COMPETENCY: **Use formula to find instantaneous voltages**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to use the correct formula to determine instantaneous values of voltage, when given the maximum voltage, and the angle of rotation, or when given the values of frequency, time, maximum voltage, and/or angle of rotation.

1.12.3 COMPETENCY: **Use formula to find instantaneous currents**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to use the correct formula to determine instantaneous values of current, when given the maximum current, and the angle of rotation.

1.12.4 COMPETENCY: **Use formula to find angle of rotation**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to use the correct formula to determine the angle of rotation, when given the value of maximum voltage, and the instantaneous voltage, or when given the value of maximum current, and the instantaneous current flow.

1.12.5 COMPETENCY: **Use formula to find maximum voltage**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to use the correct formula to determine the value of maximum voltage, when given the angle of rotation, and the instantaneous voltage.

1.12.6 COMPETENCY: **Use formula to find maximum current**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to use the correct formula to determine the value of maximum current, when given the angle of rotation, and the instantaneous current.

1.12.7 COMPETENCY: **Find frequency when given instantaneous values of voltage or current**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to find the frequency applied to a circuit, when given the value of maximum voltage or current, the angle of rotation, the time at which the reading is taken, and the instantaneous voltage or current.

1.12.8 COMPETENCY: **Transpose formula to solve all values**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to transpose the formulas used in 1.12.5 and 1.12.6 to solve for all values of unknown, as related to values of frequency, time, maximum voltage or current, and instantaneous values of voltage or current.

1.12.9 COMPETENCY: **Solve practical problems for instantaneous values**

ENABLING PERFORMANCE OBJECTIVES

The student will be able to read a description of a problem, determine what information is needed for solution of the problem, express that information in the correct form, and the proper mathematical relationship for solution, to solve the formula for the unknown values, in problems involving calculation of instantaneous values of current and voltage.

1.12.10 COMPETENCY: **Plot instantaneous values of voltage and current produced by generator**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to plot instantaneous values of voltage and current produced by an AC generator, so a graphical representation of a sinusoidal waveform can be produced.

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TERMINAL PERFORMANCE OBJECTIVES
COMPETENCIES
AND
ENABLING OBJECTIVES

ELECTRONICS THEORY

IDAHO STANDARDIZED ELECTRONICS CURRICULUM

PREPARED 13 April, 1985
REVISED 9 December, 1986
BY Electronics Curriculum Committee
Area Vocational Technical Schools
State of Idaho

State of Idaho - Electronics Technology Standardized Vocational Program

PERFORMANCE STANDARDS

The following is a list of measurable performance objectives for the Electronics Theory portion of the standardized Electronics Technology Program for the State of Idaho Vocational Electronics Curriculum.

This listing is intended to be a simple, easy to read format of the performance standards for this portion of the course. The student, as well as the instructor, can see at a glance the tasks, terminal performance objectives, competencies, and enabling performance objectives that are necessary for completion of this section.

The following list of Conditions and Criteria are intended to be used with each of the Performance Objectives listed later in this document. Where the exact conditions cannot be met, the instructor will be responsible to insure that the purpose of the objective is accomplished, to guarantee the level of learning necessary for the success of the student.

CONDITIONS:

1. The student may use a calculator, except where specifically prohibited in the objective statement.
2. All answers to mathematical calculations must be accurate to tolerances specified by the instructor.
3. Calculations involving numbers extracted from a graph must be accurate to tolerances specified by the instructor.
4. The student will be required to list units of measurement, with the numerical answer, when the unit of measurement is an integral part of the answer, such as 5 volts, 1 ampere, or 4.7 kilohms.
5. The instructor will insure that the student is exposed to the necessary activities as many times as is needed to insure that the student not only can perform the objective once, but also can retain the knowledge to use at a later time.

CRITERIA:

1. All answers must be accurate to tolerances specified by the instructor, for mathematical solutions and graphical solutions.
2. Accomplishment of the performance objective may be tested on more than one occasion, through the use of questions on subsequent exams. (Review Questions)
3. Retention of the knowledge of the information covered by the objective may be tested at a later time on a final exam, given at the end of the session.

TASKS
PERFORMANCE OBJECTIVES
COMPETENCIES
AND
ENABLING OBJECTIVES

2.1 TASK: Identify Current as an Electrical Unit

TERMINAL PERFORMANCE OBJECTIVE

1. **Define terms associated with the nature of matter.**
2. **Define what a Coulomb is.**
3. **State the Use of the Coulomb as an elementary charge.**
4. **Identify charged particles and the charge associated with each.**
5. **Define current flow, in terms of electron movement and ionization current.**
6. **Define DC and AC current and give examples of each.**

COMPETENCIES AND EPO'S

2.1.1 COMPETENCY: **Define atom**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to define the term 'atom' and be able to list the parts of the atom, as well as their unit of electrical charge.

2.1.2 COMPETENCY: **Define element**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to define the term 'element' and be able to name some of the common elements used in electronics; including carbon, copper, silicon, germanium, silver and gold.

2.1.3 COMPETENCY: **Define compound**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to define the term 'compound' and be able to describe the difference between an element, a compound, and a mixture.

2.1.4 COMPETENCY: **Define atomic number, atomic weight, shell, and valence**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to define the terms 'atomic number', 'atomic weight', 'shell', and 'valence', and discuss how these terms vary from element to element.

2.1.5 COMPETENCY: **Identify the unit of charge**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to identify the unit of charge and the component of the atom that produces that charge.

2.1.6 COMPETENCY: **Define the term coulomb**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to define the term coulomb and discuss the significance of the coulomb to the field of electronics.

2.1.7 COMPETENCY: **Define the term current flow**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to define the term 'current flow' and describe how the term relates to time and the unit of charge. The student will be required to identify the symbol and unit of measurement for current flow. The student must also be able to describe the difference between 'electron flow' and 'conventional current flow'.

2.1.8 COMPETENCY: **Define ionization current**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to define the term 'ionization current' and describe how it relates to the movement of electrons through a circuit.

2.1.9 COMPETENCY: **Define direct current**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to define the term 'direct current' and give examples of direct current waveforms, including the square wave, sawtooth wave, and pulsating DC waveform.

2.1.10 COMPETENCY: **Define alternating current**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to define the term 'alternating current' and explain the difference between DC and AC. Student will also give examples of alternating current waveforms, such as the sine wave.

TASKS
PERFORMANCE OBJECTIVES
COMPETENCIES
AND
ENABLING OBJECTIVES

2.2 TASK: Identify Voltage as an Electrical Unit

TERMINAL PERFORMANCE OBJECTIVE

1. **Define what a Volt is.**
2. **Calculate voltage in terms of energy and charge.**

COMPETENCIES AND EPO'S

2.2.1 COMPETENCY: **Identify the law of charges**

ENABLING PERFORMANCE OBJECTIVES

The student will be able to identify the law of charges and determine which charges will have an attraction for each other and which charges will repel each other.

2.2.2 COMPETENCY: **Define the term 'voltage'**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to define the term 'voltage' and list some of the sources of voltage.

2.2.3 COMPETENCY: **Write formula for voltage using energy and charge**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to write the formula for determining the voltage, when the energy in joules and the charge in coulombs are known.

TASKS
PERFORMANCE OBJECTIVES
COMPETENCIES
AND
ENABLING OBJECTIVES

2.3 TASK: Identify Types of Resistive Elements, Determine Resistor Values, and Calculate Conductance

TERMINAL PERFORMANCE OBJECTIVE

1. **Identify different types of resistive elements used in the electronics industry.**
2. **Determine their power rating or ability to dissipate heat.**
3. **Use the color code to determine the value of resistors.**
4. **Identify resistors not marked with a color code, to determine the correct value in ohms, kilohms, or megohms.**
5. **Determine whether various resistors are in or out of tolerance.**
6. **Determine the wattage rating of resistors from physical dimensions and other specifications.**
7. **Define conductance and calculate the correct value of conductance for several resistive components.**

COMPETENCIES AND EPO'S

2.3.1 COMPETENCY: **Define conductor, insulator, and semiconductor**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to define the terms 'conductor', 'insulator', and 'semiconductor', as related to the atomic structure of materials, and give at least two examples of each.

2.3.2 COMPETENCY: **Define the term resistance**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to define the term 'resistance', list the units of measurement of resistors, and show how resistance affects the current flow in an electrical circuit.

2.3.3 COMPETENCY: **Define the term conductance and calculate conductance**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to define the term 'conductance', and show how conductance is related to resistance. The student will calculate the conductance, when given the value of resistance.

2.3.4 COMPETENCY: **Identify types of resistors**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to identify the different types of resistive components, both fixed in value and variable, and list uses for the different types. The student will be required to draw the schematic symbol for the different types (such as fixed, adjustable, rheostat, and potentiometer).

2.3.5 COMPETENCY: **Use the color code to determine resistor value**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to use the color code to determine the ohmmic value, and the tolerance specified, for color coded resistors. Student must be able to do this from memory, and will not be able to use notes or text.

2.3.6 COMPETENCY: **Define the terms 'power' and 'wattage'**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to define the terms 'power' and 'wattage' as they relate to resistive components.

2.3.7 COMPETENCY: **Determine wattage rating from physical size of resistive components**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to determine the resistance of resistive components which do not have a color code to aid in identification of the resistance value.

2.3.8 COMPETENCY: **Determine resistance for non-color coded resistive components**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to determine the resistance of resistive components which do not have a color code to aid in identification of the resistance value.

2.3.9 COMPETENCY: **Determine the tolerance of resistive components**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to determine the tolerance of resistive components, in percent and in ohms, and calculate the range of resistance readings that would be acceptable for that component.

TASKS
PERFORMANCE OBJECTIVES
COMPETENCIES
AND
ENABLING OBJECTIVES

2.4 TASK: Identify Properties of Voltage Cells and Calculate Output Voltage of Series and Parallel Connected Batteries

TERMINAL PERFORMANCE OBJECTIVE

1. **Identify properties of voltage cells.**
2. **Calculate the output voltage of two or more batteries connected in series aiding or series opposing.**
3. **Calculate the effect of connecting batteries in parallel with each other.**

COMPETENCIES AND EPO'S

2.4.1 COMPETENCY: **Identify properties of dry cell batteries**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to identify the properties of the common dry cell batteries, such as the AA, A, C, and D cell batteries. The student will be able to determine the output voltage of each of these batteries and discuss differences in the batteries in terms of current and power dissipation.

2.4.2 COMPETENCY: **Identify properties of wet cell batteries**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to identify the properties of the wet cell, or storage battery, such as is used in the automobile. The student will be able to determine output voltage and ampere hour rating.

2.4.3 COMPETENCY: **Identify properties of rechargeable batteries**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to identify the properties of the common rechargeable batteries, such as the NI-Cad, in terms of output voltage and current capabilities.

2.4.4 COMPETENCY: **Calculate output voltage of batteries or power supplies in series aiding**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to calculate the output voltage, or total voltage, of batteries, or power supplies that are connected in series, with the + end of one battery connected to the - end of the next, for two or more batteries.

2.4.5 COMPETENCY: **Calculate output voltage of batteries or power supplies in series opposing**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to calculate the output voltage, or total voltage, of batteries or power supplies, that are connected in series, with the batteries opposing each other, or with the + end of one supply connected to the + end of the next, for two or more batteries.

2.4.6 COMPETENCY: **Calculate output voltage of parallel batteries**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to calculate the output voltage of two or more batteries, or power supplies, connected in parallel, and list one advantage of connecting power sources in parallel with each other.

TASKS
PERFORMANCE OBJECTIVES
COMPETENCIES
AND
ENABLING OBJECTIVES

2.5 TASK: Describe How DC Voltage is Generated Electro-Mechanically

TERMINAL PERFORMANCE OBJECTIVE

1. **Describe the theory of operation of the DC generator.**
2. **Draw a graph of voltage versus time at the output of the DC generator.**
3. **Draw a graph of voltage versus degress of rotation of the DC generator.**
4. **Describe the effect of increasing or decreasing the number of poles of the DC generator, or otherwise changing the construction of the generator.**
5. **List six sources of electricity.**

COMPETENCIES AND EPO'S

2.5.1 COMPETENCY: **Describe operation of DC generator**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to describe the theory of operation of the DC generator, or select statements describing the operation of the DC generator, from a list of possible statements concerning the DC generator.

2.5.2 COMPETENCY: **Graph voltage and time in DC generator**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to draw a graph of voltage output versus time, at the output of the DC generator, and list the factors which affect the amplitude of the output voltage.

2.5.3 COMPETENCY: **Graph voltage and degrees of rotation of a DC generator**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to draw a graph of voltage output versus degrees of rotation of the DC generator.

2.5.4 COMPETENCY: **Describe effect of changing construction of DC generator**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to describe the effect of changing the number of poles of the generator, or changing the size of the magnetic pole pieces, or changing the winding of the armature of the generator.

2.5.5 COMPETENCY: **Describe sources of electrical power**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to list six methods of generating electricity, and briefly describe how each method produces electrical current flow.

TASKS
PERFORMANCE OBJECTIVES
COMPETENCIES
AND
ENABLING OBJECTIVES

2.6 TASK: Ohm's Law Calculations for DC Circuits

TERMINAL PERFORMANCE OBJECTIVE

1. **Solve for total current flow in a DC circuit when given the necessary values of voltage and resistance.**
2. **Solve for current flow through any individual component, when given the necessary values of voltage and resistance, at key points in the circuit.**
3. **Calculate the value of total resistance when given the necessary values of voltage, current, or resistance at key points in the circuit.**
4. **Calculate the value of any individual resistor when given the necessary values of voltage, resistance, or current at key points in the circuit.**
5. **Calculate the value of total voltage applied to the circuit, when given the necessary values of current, resistance, or voltage at key points in the circuit.**
6. **Calculate the value of voltage across any individual component, when given the necessary values of current, resistance, and/or voltage at key points in the circuit.**
7. **Calculate the internal resistance of a power source when given the necessary information about the power source.**
8. **Determine circuit values for loaded and unloaded voltage and current divider circuits.**
9. **Analyze bridge circuits and determine circuit values, using formula for solution of bridge circuits.**
10. **Graph the results of Ohm's law formula calculations, to demonstrate graphically how current, voltage, and resistance are related.**

COMPETENCIES AND EPO'S

2.6.1 COMPETENCY: **Calculate total resistance in series circuits**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to evaluate the requirements for a complete circuit and calculate the total resistance of two or more resistors in series, when given one of the following conditions:

1. the resistance values of each of the individual resistors
2. the total voltage applied to the circuit and the total current flowing in the circuit
3. the total power dissipated and the total current
4. the total power and the total voltage
5. sufficient information to find the above mentioned parameters.

2.6.2 COMPETENCY: **Calculate total current in series circuits**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to calculate the total current flowing in a series circuit, when given one of the following conditions:

1. all resistor values and the total voltage
2. the voltage drop across any individual resistor and the resistance of the resistor
3. the power consumed by an individual resistor and the value of the resistor
4. total resistance and the total voltage
5. sufficient information to find the above mentioned parameters.

2.6.3 COMPETENCY: **Calculate total voltage in series circuits**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to calculate the total voltage applied to a series circuit, and determine the polarity of the voltage drops, when given one of the following conditions:

1. all resistor values and the total current
2. total resistance and total current
3. total power consumed by the circuit and total resistance of the circuit
4. the voltage drops across the individual components
5. total power consumed by the circuit and the total current flowing in the circuit
6. sufficient information to find the above mentioned parameters.

2.6.4 COMPETENCY: **Calculate total power consumed in series circuits**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to calculate the total power consumed by a series circuit, when given one of the following conditions:

1. total current and total voltage
2. total current and total resistance
3. total voltage and total resistance
4. total current and the values of the individual resistors
5. total voltage and the values of the individual resistors
6. the power consumed by each individual component
7. sufficient information to find the above mentioned parameters.

2.6.5 COMPETENCY: **Calculate individual voltage drops in series**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to calculate the voltage dropped across each component in a series circuit, and determine the polarity of the voltage drops, when given one of the following conditions:

1. the total current and the individual resistor values
2. the total voltage and the individual resistor values
3. the current through the component and the value of the component
4. the total voltage and the voltages across all other components in the circuit
5. sufficient information to find the above mentioned parameters.

2.6.6 COMPETENCY: **Power consumed by each component in series circuits**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to calculate the power consumed by the individual components in a series circuit, when given one of the following conditions:

1. the current flow through the component and the resistance value of the component
2. the voltage drop across the component and the resistance value of the component
3. the voltage drop across the component and the current through the component
4. the total power consumed by the circuit and the power consumed by each of the other components in the circuit
5. sufficient information to find the above mentioned parameters.

2.6.7 COMPETENCY: **Current flow through each component in series circuit**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to calculate the current flow through each component in a series circuit, when given one of the following conditions:

1. the voltage across the component and the resistance of the component
2. the total voltage and total resistance in the circuit
3. the total current
4. the total power and the total current
5. the total power and the total voltage
6. sufficient information to find the above mentioned parameters.

2.6.8 COMPETENCY: **Calculate total resistance in parallel circuits**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to calculate the total resistance of a parallel circuit, when given one of the following conditions:

1. total voltage applied to the circuit and total current flowing in the circuit
2. the value of each resistor in the circuit
3. the conductance of each resistor in the circuit
4. the current flow in each branch of the circuit and the total voltage
5. total power consumed by the circuit and the total current flow
6. total power consumed by the circuit and the total voltage applied to the circuit
7. sufficient information to find the above parameters.

2.6.9 COMPETENCY: **Calculate current flow in each branch of a parallel circuit**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to calculate the current flow in each branch of a parallel circuit, when given one of the following conditions:

1. total voltage and value of the resistance in the branch
2. total current and the current flow in each of the other branches
3. sufficient information to find the above mentioned parameters.

2.6.10 COMPETENCY: **Calculate voltage drop across each component in a parallel circuit**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to calculate the voltage drop across each component in a parallel circuit, and determine the polarity of the voltage drops, when given one of the following conditions:

1. the total voltage applied to the circuit
2. the current flow through the branch and the resistance of the branch
3. the total power consumed by the circuit and the total resistance of the circuit
4. sufficient information to find the above mentioned parameters.

2.6.11 COMPETENCY: **Calculate total power in parallel circuits**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to calculate the total power consumed by a parallel circuit, when given one of the following conditions:

1. total current flow in the circuit and total voltage applied
2. total resistance in the circuit and total current flow
3. power consumed by each individual resistor
4. sufficient information to find the above mentioned parameters.

2.6.12 COMPETENCY: **Calculate total resistance in series-parallel circuits**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to calculate the total resistance of the series-parallel circuit, when given sufficient information concerning individual resistor values, voltage, current, and/or power at key points in the circuit. The student will apply the rules for series circuits, as stated in previous competencies, for the series portion of the circuit, and the rules for solution of parallel circuits, also stated in previous competencies, for the parallel portion of the circuit.

2.6.13 COMPETENCY: **Calculate voltage drops in series-parallel circuits**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to calculate the voltage dropped across each component in the series-parallel circuit, and the polarity of the voltage drops, when given the necessary information concerning individual resistor values, voltage, current, and/or power at key points in the circuit. The student will apply the rules for series circuits, as stated in previous competencies, for the series portion of the circuit, and the rules for solution of parallel circuits, also stated in previous competencies, for the parallel portion of the circuit.

2.6.14 COMPETENCY: **Calculate current through each component in series-parallel circuits**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to calculate the current flowing through each component in a series-parallel circuit, when given the necessary information concerning individual resistor values, voltage, current, and/or power at key points in the circuit. The student will apply the rules for series circuits, stated in previous competencies, for the series portion of the circuit, and the rules for solution of parallel circuits, also stated in previous competencies, for the parallel portion of the circuit.

2.6.15 COMPETENCY: **Calculate power for each component in series parallel circuits**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to calculate the power consumed by each component in a series-parallel circuit, when given the necessary information concerning individual resistor values, voltage, current, and/or power at key points in the circuit. The student will apply the rules for series circuits, stated in previous competencies, for the series portion of the circuit, and the rules for solution of parallel circuits, also stated in previous competencies, for the parallel portion of the circuit.

2.6.16 COMPETENCY: **Calculate individual resistor values**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to calculate individual resistor values, in series, parallel, or series-parallel combination circuits, when given the necessary information concerning resistor values of other resistors in the circuit, voltage, current, and/or power at key points in the circuit. The student will apply the rules for series circuits, stated in previous competencies, for the series circuit problems, and the rules for solution of parallel circuits, also stated in previous competencies, for the parallel circuit problems.

2.6.17 COMPETENCY: **Calculate total power in series-parallel circuits**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to calculate the total power consumed by the series-parallel circuit, when given the necessary values of individual resistors, voltage, current, and/or power consumed at key points in the circuit. The student will apply the rules for series circuits, stated in previous competencies, for the series portion of the circuit, and the rules for solution of parallel circuits, also stated in previous competencies, for the parallel portion of the circuit.

2.6.18 COMPETENCY: **Use voltage divider formula**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to use the proportionality formula (voltage divider formula) to determine the voltage drops in an unloaded voltage divider circuit.

2.6.19 COMPETENCY: **Use current divider formula**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to use the proportionality formula (current divider formula) to determine the current flow through each branch of a parallel current divider circuit.

2.6.20 COMPETENCY: **Use conductance formula to compute current**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to use the conductance formula to determine the current flow through any branch of a parallel circuit.

2.6.21 COMPETENCY: **Determine circuit conditions in loaded voltage divider circuit**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to calculate the bleeder current, load current, and voltage drops for a multiple output voltage divider, by using Ohms law, Kirchoffs laws, and other voltage and current divider formulas.

2.6.22 COMPETENCY: **Analyze circuit conditions in bridge circuits**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to analyze a bridge circuit, and determine the voltage across, and the current through, the resistor in the center of a bridge circuit, by using the formula for solution of bridge circuit.

2.6.23 COMPETENCY: **Troubleshooting in DC circuits**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to use the knowledge gained in the previous competencies, to determine the cause of abnormal voltage, current, resistance, and/or power readings in a series, parallel, or series-parallel circuit. The student will be given the necessary information concerning abnormal results and will use mathematical means to determine the cause of the abnormal reading. The student will then indicate the precise nature of the abnormality; such as R101 open, S203 shorted to ground, R406 shorted, R111 out of tolerance, open connection between test point A and R102, etc.

2.6.24 COMPETENCY: **Graph ohms law results**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to construct a graph illustrating the relationship between voltage, current, and resistance, in simple DC electrical circuits.

TASKS
PERFORMANCE OBJECTIVES
COMPETENCIES
AND
ENABLING OBJECTIVES

2.7 TASK: Analyze the Properties of DC Meter Circuits

TERMINAL PERFORMANCE OBJECTIVE

1. Describe the operation of a meter movement.
2. Determine the current necessary for full scale deflection of the meter needle.
3. Calculate the resistance of the meter movement.
4. Define the term meter shunt.
5. Calculate the value of shunt current.
6. Calculate the value of shunt resistance for a given meter range.
7. Determine the Ohms/volt rating of a meter.
8. Determine the meter resistance of any given voltage scale.
9. Calculate the loading effect of the voltmeter, on any given scale, and for any given circuit to be measured.
10. Explain how the loading effect can be reduced.
11. Calculate the value of multiplier resistor needed for any given voltage scale.
12. Calculate circuit values for a single range voltmeter.
13. Determine rorrect values for shunt and multiplier resistors for a multiple range ohmmeter.

COMPETENCIES AND EPO'S

2.7.1 COMPETENCY: Explain how meters work

ENABLING PERFORMANCE OBJECTIVE

The student will be able to explain the basic operation of a meter circuit, when the meter circuit is being used as a voltmeter, ammeter, or ohmmeter.

2.7.2 COMPETENCY: Calculate full scale current

ENABLING PERFORMANCE OBJECTIVE

The student will be able to calculate the current required to produce full scale deflection of the meter needle, when given voltage drop across the meter movement, and resistance of the meter movement, or sufficient information to obtain the necessary data.

2.7.3 COMPETENCY: Calculate voltage drop across meter movement

ENABLING PERFORMANCE OBJECTIVE

The student will be able to calculate the voltage drop across the meter movement, when given the full scale current and resistance of the meter movement, or sufficient information to obtain the necessary data.

2.7.4 COMPETENCY: **Calculate meter resistance**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to calculate the resistance of the meter movement, when given the full scale current, and the voltage drop across the meter, or sufficient information to obtain the necessary data.

2.7.5 COMPETENCY: **Calculate shunt current**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to calculate the value of shunt current that will flow through the shunt resistor in a meter circuit used as an ammeter, for any given current range, when given the value of meter resistance, meter current for full scale deflection, and/or voltage drop across the meter movement.

2.7.6 COMPETENCY: **Define and calculate the value of meter shunt**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to define the term 'meter shunt', and explain the relationship to the ammeter circuit. He/she will also calculate the value of meter shunt to be used for a given range of current measurement, when given the value of meter resistance, and current required for full scale deflection of the meter needle.

2.7.7 COMPETENCY: **Calculate ohms/volt rating**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to determine the sensitivity of a meter, in ohms/volt, when given either the full scale current of the meter movement, or the resistance of the meter on a particular voltage scale.

2.7.8 COMPETENCY: **Calculate resistance of meter on voltage scale**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to calculate the resistance of the meter assigned to him/her, on any voltage scale, when given the meter sensitivity in ohms/volt, the full scale deflection current of the meter movement, or information sufficient to determine the necessary data.

2.7.9 COMPETENCY: **Determine loading effect of voltmeter**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to calculate the loading effect of the voltmeter assigned, when given a circuit with high resistance values, and low voltages to be measured. The student will calculate theoretical voltage readings with a non-loading voltmeter, and the actual voltage readings, and be able to explain the reason for the differences in readings, if any, and explain what can be done to minimize loading effect of the meter.

2.7.10 COMPETENCY: **Determine insertion effect of ammeter**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to calculate the insertion effect of the ammeter assigned, when given a circuit with low resistance values, and low current values to be measured. The student will calculate theoretical current readings with an ammeter having no insertion losses, and the actual current readings. The student will be able to explain the reason for the differences in readings, if any, explain what can be done to minimize the insertion effect of the meter.

2.7.11 COMPETENCY: **Calculate values of multiplier resistors**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to calculate the value of the meter multiplier resistor used for any given voltage scale, when given the full scale current of the meter movement, the voltage drop across the meter movement, the resistance of the meter movement, and/or sufficient information to obtain the necessary data.

2.7.12 COMPETENCY: **Calculate circuit values for single range voltmeter**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to calculate the circuit values for a single range voltmeter, when given the necessary data concerning full scale deflection current, voltage across the meter movement, meter resistance, and/or other information about the meter sensitivity.

2.7.13 COMPETENCY: **Calculate values for multiple range ohmmeter**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to calculate values for the components in a multiple range ohmmeter, having at least 3 scales, when given the necessary information concerning meter sensitivity, full scale deflection current, and/or other information needed to obtain the required data.

TASKS
PERFORMANCE OBJECTIVES
COMPETENCIES
AND
ENABLING OBJECTIVES

2.8 TASK: Analyze Resistive Networks Using Network Analysis Techniques

TERMINAL PERFORMANCE OBJECTIVE

1. Explain what a constant current source is, and list the characteristics of an ideal constant current source.
2. Explain what a constant voltage source is, and list the characteristics of an ideal constant voltage source.
3. Compare the ideal constant current source to the actual practical constant current source, and list the differences between the two.
4. Compare the ideal constant voltage source to the actual practical constant voltage source, and list the differences between the two.
5. Compute current flow through any component in a DC circuit, containing more than one voltage supply, by using the Superposition theorem.
6. Draw the Thevenin's equivalent circuit and determine the values of open circuit voltage, equivalent resistance, load voltage, and load current, for a DC circuit connected in series-parallel, with or without multiple voltage sources.
7. Compute short circuit current, I_N, equivalent resistance, R_N, load current, and load voltage, in a DC circuit, by using Norton's theorem.
8. Determine the voltage across any component in a series parallel circuit by using Kirchoff's voltage law.
9. Calculate the current through any component in a series parallel circuit by using Kirchoff's current law.

COMPETENCIES AND EPO'S

2.8.1 COMPETENCY: Draw Thevenin's equivalent of voltage source

ENABLING PERFORMANCE OBJECTIVE

The student will be able to draw the Thevenin's equivalent circuit of a practical voltage source, and properly label the schematic.

2.8.2 COMPETENCY: List characteristics of ideal constant voltage source

ENABLING PERFORMANCE OBJECTIVE

The student will be able to explain what a constant voltage source is, and list the characteristics necessary to be an ideal constant voltage source. The student will compare the ideal constant voltage source to the practical voltage source, and list the differences between the two.

2.8.3 COMPETENCY: **Draw Norton equivalent circuit of current source**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to draw the Norton equivalent circuit of a current source, and properly label the schematic diagram.

2.8.4 COMPETENCY: **List characteristics of ideal constant current source**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to explain what a constant current source is, and list the characteristics necessary to be an ideal constant current source. The student will compare the ideal constant current source to the practical current source and list differences between the two.

2.8.5 COMPETENCY: **Convert voltage source to current source**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to convert a voltage source to an equivalent current source, and draw the schematic diagram for both, with all values of current flow, voltage drops, and resistance, listed on the schematic diagram.

2.8.6 COMPETENCY: **Convert current source to voltage source**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to convert a current source to an equivalent voltage source, and draw the schematic diagram for both, with all values of current flow, voltage drops, and resistance, listed on the schematic diagram.

2.8.7 COMPETENCY: **Use Superposition theorem to anlyze DC circuits**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to analyze a series-parallel circuit, containing two voltage sources, using the Superposition theorem, and determine the current through any resistor selected as the load resistor.

2.8.8 COMPETENCY: **Use Thevenin's theorem to analyze DC circuits**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to analyze a complex series-parallel circuit, with or without multiple voltage sources (no more than two), and determine the open circuit voltage (V_{th}), the equivalent resistance (R_{th}), current through the load, and voltage across the load, by using Thevenin's theorem. The student will draw the schematic diagram of the Thevenin equivalent circuit, with all circuit values listed on the schematic.

2.8.9 COMPETENCY: **Use Norton's theorem to analyze DC circuits**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to analyze a complex series-parallel circuit, with or without multiple voltage sources (no more than two), and determine the short circuit current (I_N), equivalent resistance (R_N), load current, and load voltage, using Norton's theorem. The student will draw the schematic diagram of the Norton equivalent circuit, with all circuit values listed on the schematic.

2.8.10 COMPETENCY: **Use Kirchoff's voltage law to analyze DC circuits**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to analyze a complex series-parallel circuit, with or without multiple voltage sources, (no more than two), and determine the voltage across any component in the circuit, by using Kirchoff's voltage law as the method of analysis.

2.8.11 COMPETENCY: **Use Kirchoff's current law to analyze DC circuits**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to analyze a complex series-parallel circuit, with or without multiple voltage sources, (no more than two), and determine the current flow through any component in the circuit, by using Kirchoff's current law as the method of analysis.

TASK
PERFORMANCE OBJECTIVES
COMPETENCIES
AND
ENABLING OBJECTIVES

2.9 TASK: Analyzing Resistive Delta and Wye Circuits

TERMINAL PERFORMANCE OBJECTIVE

1. **Identify a resistive delta connected circuit.**
2. **Identify a resistive wye connected circuit.**
3. **Compute the values of the equivalent wye connected circuit for a given delta connected resistive circuit.**
4. **Compute the values of the equivalent delta connected circuit for a given wye connected resistive circuit.**

COMPETENCIES AND EPO'S

2.9.1 COMPETENCY: **Calculate values for equivalent wye circuit**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to recognize a delta connected circuit and use the formula for converting from delta form to wye form.

2.9.2 COMPETENCY: **Draw a delta circuit as a wye circuit**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to draw the equivalent wye circuit for any given delta circuit and list the values of resistors on the schematic diagram.

2.9.3 COMPETENCY: **Calculate values for equivalent delta circuit**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to recognize a wye connected circuit, and use the formula for converting from wye form to delta form.

2.9.4 COMPETENCY: **Draw a wye circuit as a delta circuit**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to draw the equivalent delta circuit for any given wye circuit and list the values of resistors on the schematic diagram.

TASK
PERFORMANCE OBJECTIVES
COMPETENCIES
AND
ENABLING OBJECTIVES

2.10 TASK: Calculate Circuit Values in Capacitive Circuits

TERMINAL PERFORMANCE OBJECTIVE

1. Calculate the voltage across, and the current through, the resistor in an RC circuit, at any point in time due to the charging of the capacitor from a DC source.
2. Calculate the voltage across the capacitor in an RC circuit, at any point in time, due to the charging of the capacitor from a DC voltage source.
3. Calculate the voltage across, and the current through the resistor in an RC circuit, at any point in time, due to the discharge of the capacitor.
4. Calculate the voltage across the capacitor in an RC circuit, at any point in time due to the discharge of the capacitor.

COMPETENCIES AND EPO'S

2.10.1 COMPETENCY: Identify a capacitor and draw the schematic symbol

ENABLING PERFORMANCE OBJECTIVE

The student will be able to identify a capacitor, determine the capacitor value, and draw the schematic symbols for capacitors.

2.10.2 COMPETENCY: Discuss the construction techniques used to produce capacitors

ENABLING PERFORMANCE OBJECTIVE

The student will be able to describe the various techniques used in the construction of the different types of capacitors. Discuss the differences between ideal and practical capacitors, and identify the losses involved.

2.10.3 COMPETENCY: Discuss how physical dimensions and materials affect capacitance

ENABLING PERFORMANCE OBJECTIVE

The student will be able to:

1. Describe the effects of area, distance between capacitor plates, and dielectric material on capacitance and how it affects power factor.
2. Calculate the capacitance of a capacitor, when given the necessary dimensions to determine plate area, spacing between the plates, and type of dielectric material.

2.10.4 COMPETENCY: **Analyze the electric field within a capacitor**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to:

1. Describe the effect of applying a voltage to the plates of a capacitor in terms of the electric field produced between the plates of the capacitor.
2. Describe the effect of the electric field produced between the plates of a capacitor, on the dielectric material used within the capacitor.

2.10.5 COMPETENCY: **Calculate RC time constants**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to:

1. Calculate the RC time constant for a given set of circuit values.
2. Calculate values of voltage and current at any given time from the start of capacitor charge or discharge for a DC circuit under transient conditions.
3. Quote from memory the percent of charge or discharge for 1 time constant and for 5 time constants.

2.10.6 COMPETENCY: **Calculate total capacitance in series**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to calculate the value of total capacitance of capacitors connected in series, when given the values of the individual capacitors.

2.10.7 COMPETENCY: **Calculate total capacitance in parallel**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to calculate the value of total capacitance of capacitors connected in parallel, when given the values of the individual capacitors.

2.10.8 COMPETENCY: **Discuss effects of stray capacitance**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to discuss the effects of stray inductance in DC and AC circuits for wire as well as other electrical components, such as resistors and coils. List the symbols used and draw equivalent circuits showing the effects of stray capacitance.

2.10.9 COMPETENCY: **Calculate voltage and current in capacitive circuits**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to calculate the amount of voltage across the components in the circuit and current flowing through each of the components in the circuit for any period of time in an RC circuit.

2.10.10 COMPETENCY: **Discuss RC differentiator circuits**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to describe the theory of operation of the RC differentiator circuit, with a square wave pulse signal applied, and draw the resultant waveform for a given signal input.

2.10.11 COMPETENCY: **Discuss RC integrator circuits**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to describe the theory of operation of the RC integrator circuit, with a square wave pulse signal applied, and draw the resultant waveform for a given signal input.

2.10.12 COMPETENCY: **Describe relationship of RC time to frequency response**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to describe how the RC time constant of the circuit will affect the frequency response of an RC circuit.

TASKS
PERFORMANCE OBJECTIVES
COMPETENCIES
AND
ENABLING OBJECTIVES

2.11 Analyze the Effects of Inductance in DC and AC Circuits

TERMINAL PERFORMANCE OBJECTIVE

1. List the factors that determine the amount of inductance in a coil.
2. Calculate the RL time constant of an inductive-resistive circuit.
3. Calculate the value of voltage, and current at 1, 2, 3, 4, and 5 time constants for charge or discharge of the inductive circuit.
4. Quote from memory the percentage of voltage or current for 1, 2, 3, 4, or 5 time constants.
5. Determine the mutual inductance of two coils when they are aiding or opposing each other.
6. Calculate the coefficient of coupling between two coils.
7. Calculate total inductance of two coils in series or parallel, aiding or opposing each other.

COMPETENCIES AND EPO'S

2.11.1 COMPETENCY: Discuss Properties of Permanent Magnets

ENABLING PERFORMANCE OBJECTIVE

1. The student will describe how a permanent magnet works and explain the terms associated with magnets; such as permeability, reluctance, magnetizing force, and magnetic field strength.
2. The student will discuss "Ohm's Law" for magnetic circuits.

2.11.2 COMPETENCY: Discuss effect of physical factors on inductance

ENABLING PERFORMANCE OBJECTIVE

The student will be able to:

1. Describe the effects of increasing or decreasing the number of turns of wire on an inductor.
2. Describe the effect that physical dimensions have on the inductance of a coil.
3. Describe the effects the type of core material have on inductance.
4. Describe the effects of lengthening or shortening the core on inductance.
5. Describe the effects of increasing or decreasing the radius of the core on inductance.
6. List the units of measurement of inductance, and identify the schematic symbol for inductances.

2.11.3 COMPETENCY: **Calculate inductance in terms of physical characteristics**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to:

1. Calculate the value of inductance of a coil, when given the necessary information concerning physical dimensions, turns of wire, type of core, etc.
2. Describe the effects of the magnetic circuit produced in an inductor.
3. Describe the differences between the ideal inductor and the practical inductor and explain the reasons for the differences.

2.11.4 COMPETENCY: **Calculate inductance in terms of electrical characteristics**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to calculate the inductance of a coil, when given:

1. The time constant of the circuit and the resistance in the circuit.
2. The inductive reactance and the frequency applied to the circuit.
3. The energy stored in the magnetic field and current flow through the inductor.
4. The reactive power (apparent power), the frequency, and the current flow through the inductor.
5. The impedance, the frequency, and the phase angle of the circuit.

2.11.5 COMPETENCY: **Calculate induced voltage in the coil**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to calculate the voltage induced in a coil, when given the number of turns in the coil and the rate of flux change.

2.11.6 COMPETENCY: **List the symbols and units of mutual inductance**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to state the formula for determining mutual inductance of two coils, explain what each term means and state the unit of measurement for each term.

2.11.7 COMPETENCY: **Calculate mutual inductance between two coils**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to calculate the mutual inductance between two coils, when given the coefficient of coupling and the inductance of the two coils.

2.11.8 COMPETENCY: **Calculate coefficient of coupling**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to calculate the coefficient of coupling between two coils, when given the magnetic flux linking the two coils and the total magnetic flux of one coil. The student will state how the coefficient of coupling is affected by alignment and physical placement of the coils and the core material the coils are wound on.

2.11.9 COMPETENCY: **Discuss loose and tight coupling**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to discuss the terms 'loose' and 'tight' coupling, and describe how the voltage induced on two coils is affected by both types of coupling.

2.11.10 COMPETENCY: **Calculate total inductance in series**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to calculate the total inductance of two coils hooked in series. The coils may be hooked such that their magnetic fields are aiding each other, or with their fields opposing each other. Mutual inductance may or may not be a factor to be considered in the calculations.

2.11.11 COMPETENCY: **Calculate total inductance in parallel**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to calculate the total inductance of two coils hooked in parallel. The coils may be hooked such that their magnetic fields are aiding each other, or with their fields opposing each other. Mutual inductance may or may not be a factor to consider in the calculations.

2.11.12 COMPETENCY: **Discuss effects of stray inductance**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to discuss the effects of stray inductance in DC and AC circuits, for wire, as well as the stray inductance exhibited by other electrical components such as resistors and capacitors. List the symbols used and draw equivalent circuits showing the effects of the stray inductance.

2.11.13 COMPETENCY: **Calculate time constant of inductive circuits**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to calculate the time constant for an LR circuit, when given the value of resistance and inductance in the circuit. The student will calculate the percentage of rise or decay of current and voltage for the components in the circuit for any number of time constants up to 5 time constants.

2.11.14 COMPETENCY: **Calculate voltage and current in inductive circuits**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to calculate the amount of voltage across the components in the circuit, and current flowing through each of the components in the circuit, for any number of LR time constants, up to 5 time constants.

2.11.15 COMPETENCY: **Discuss RL differentiator circuits**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to describe the theory of operation of the RL differentiator circuit with a square wave pulse signal applied and draw the resultant waveform for a given signal input.

2.11.16 COMPETENCY: **Discuss RL integrator circuits**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to describe the theory of operation of the RL integrator circuit, with a square wave pulse signal applied, and draw the resultant waveform for a given signal input.

2.11.17 COMPETENCY: **Describe relationship of L/R time to frequency response**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to describe how the LR time constant of the circuit will affect the frequency response of an LR circuit.

TASKS
PERFORMANCE OBJECTIVES
COMPETENCIES
AND
ENABLING OBJECTIVES

2.12 TASK: Identify the Classifications, Discuss Characteristics, Identify Sources, and Calculate Instantaneous Values of AC Voltage and Current

TERMINAL PERFORMANCE OBJECTIVE

1. **Calculate the values of peak to peak voltage, peak voltage, average voltage, and root-mean-square voltage measurements.**
2. **Convert from one type of measurement to another.**
3. **Determine the amplitude, frequency, and phase with respect to a given reference signal, by using an oscilloscope type of picture as a reference.**
4. **Calculate the instantaneous voltage in an AC circuit.**
5. **Calculate the instantaneous current in an AC circuit.**

COMPETENCIES AND EPO'S

2.12.1 COMPETENCY: **Draw and label sine wave**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to draw a sine wave of one complete cycle and label the waveform in terms of Emax, degrees, radians, and time interval for any given number of degrees on the waveform. The student will relate time interval to frequency of the signal.

2.12.2 COMPETENCY: **Determine peak voltage of a sine wave**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to determine the peak voltage of a sinusoidal waveform, when given an oscilloscope type display of the waveform with the vertical units/division labeled.

2.12.3 COMPETENCY: **Determine peak to peak voltage of sine wave**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to determine the peak to peak voltage of a sinusoidal waveform, when given an oscilloscope type display of the waveform with the vertical units/division labeled.

2.12.4 COMPETENCY: **Determine the effective voltage of sine wave**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to determine the effective (RMS) voltage of a sinusoidal waveform, when given an oscilloscope type display of the waveform, with the vertical units/division labeled, or when given either the peak voltage, peak to peak voltage, or average voltage.

2.12.5 COMPETENCY: **Determine average voltage of sine wave**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to determine the average voltage of a sine wave, when given an oscilloscope type display of the waveform with the vertical units/division labeled, or when given either the peak voltage, the peak to peak voltage, or effective voltage.

2.12.6 COMPETENCY: **Calculate frequency of sine wave using time**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to calculate the frequency of a given sine wave, using the period as a reference, when given an oscilloscope type display of a sine wave, with the horizontal units/division labeled, or when given the period of one cycle.

2.12.7 COMPETENCY: **Calculate phase relationship between two sine waves**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to calculate the phase relationship between two sinusoidal waveforms, when given an oscilloscope type display of the two signals, with the horizontal units/division labeled, or when given the time of lead or lag of waveforms, along with total period of one cycle.

2.12.8 COMPETENCY: **Convert measurements from one form to another**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to convert average voltage or current readings to RMS, peak, and peak to peak; RMS readings to peak, peak to peak, or average; peak readings to peak to peak, RMS, or average; and peak to peak readings to peak, average, and RMS.

2.12.9 COMPETENCY: **Calculate instantaneous voltages and currents**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to calculate values of instantaneous voltage or current, when given the maximum voltage, and the number of degrees of voltage or current in question.

2.12.10 COMPETENCY: **Identify nonsinusoidal waveforms by name**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to identify the sawtooth waveform, pulsating DC waveform, integrated waveform, differentiated waveform, and square wave by name, and define the terms 'rise time' and 'fall time' (decay time), as related to the square wave.

TASKS
PERFORMANCE OBJECTIVES
COMPETENCIES
AND
ENABLING OBJECTIVES

2.13 TASK: Convert AC Voltage, Current, and Impedance Into Vector Quantities

TERMINAL PERFORMANCE OBJECTIVE

1. **Express AC voltages, currents, and impedances as vector quantities, by using both rectangular and polar notation.**
2. **Graph the values of AC voltages, currents, and impedances, by using rectangular graph paper.**
3. **Calculate reactive power, apparent power, and true power in an AC circuit.**
4. **Calculate the cutoff frequency, voltage across each circuit component at specified frequencies, and amount of output signal expressed in volts as well as DB,** for a simple two port passive filter circuit.

COMPETENCIES AND EPO'S

2.13.1 COMPETENCY: **Calculate capacitive reactance**

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to calculate capacitive reactance, when given the necessary circuit conditions of frequency, and capacitance.
2. The student will be able to calculate capacitive reactance, when given the necessary circuit conditions of impedance, current, voltage, power, etc.

2.13.2 COMPETENCY: **Calculate inductive reactance**

ENABLING PERFORMANCE OBJECTIVE

1. The student will calculate the inductive reactance of an inductor, when given the necessary values of inductance and frequency.
2. The student will calculate the inductive reactance of an inductor, when given the necessary values of impedance, current, voltage, or power.

2.13.3 COMPETENCY: **Define impedance and express as complex number**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to define the term impedance and express the term impedance as a complex number.

2.13.4 COMPETENCY: **Define admittance and write as complex number**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to define the term admittance and write admittance as a complex number.

2.13.5 COMPETENCY: **Define susceptance and express as complex number**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to define the term susceptance and write the term susceptance as a complex number.

2.13.6 COMPETENCY: **Discuss the effect of skin resistance on inductors**

ENABLING PERFORMANCE OBJECTIVE

The student will describe the effects of skin resistance on inductors as the applied frequency is increased, and/or be able to select the correct statements from a list of possible choices concerning skin effect.

2.13.7 COMPETENCY: **Convert quantities expressed in rectangular form to polar form**

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to convert AC voltages and currents expressed in rectangular form to polar notation.
2. The student will be able to convert AC voltages and currents expressed as a vector quantity to polar notation.

2.13.8 COMPETENCY: **Convert quantities expressed in polar form to rectangular form**

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to convert AC voltages or currents expressed in polar form to rectangular notation.
2. The student will be able to convert AC voltages or currents expressed as a vector quantity to rectangular notation.

2.13.9 COMPETENCY: **Calculate voltage, current, and impedance in AC circuits**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to calculate voltage, current, and impedance, when given the necessary values of capacitance, inductance, resistance, frequency, inductive reactance, and/or capacitive reactance, or sufficient information about the circuit to determine the necessary data.

2.13.10 COMPETENCY: **Draw phasor diagrams of waveforms that are in phase with each other**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to draw phasor diagrams showing the in phase relationship of two waveforms (i.e. the voltage across and current through a resistor).

2.13.11 COMPETENCY: **Draw phasor diagrams of waveforms that are out of phase with each other**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to draw a phasor diagram of two signals that are 'out of phase' with each other (i.e. voltage across and current through, a reactive component). The phasor will show the amount of phase difference, and show the amount of lead or lag of one signal in comparison to the other.

2.13.12 COMPETENCY: **Calculate instantaneous values of time related waveforms**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to calculate the instantaneous values of two timed related waveforms, for any given time, for signals which are the same frequency, or for signals that are time related, such as harmonic frequencies.

2.13.13 COMPETENCY: **Calculate power in an AC Circuit**

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to calculate apparent power, reactive power, and true power consumed by an AC circuit, when given the necessary information concerning the circuit conditions, to determine phase angle, ratio of resistance to impedance, or ratio of resistive power to reactive power, or apparent power.

2.13.14 COMPETENCY: **Calculate frequency, voltage, and output signal amplitude, for simple filter circuit**

ENABLING PERFORMANCE OBJECTIVE

1. When given the necessary circuit values for a simple two port passive filter, both low pass and high pass, the student will be able to calculate the cutoff frequency, voltage across each circuit component at specified frequencies, and amount of output signal expressed in volts as well as DB.

TASKS
PERFORMANCE OBJECTIVES
COMPETENCIES
AND
ENABLING OBJECTIVES

2.14 TASK: Calculate Voltage, Current, Impedance and Power By Using Network Analysis Theorems

TERMINAL PERFORMANCE OBJECTIVE

1. **When given the necessary circuit values, the student will be able to calculate the voltage, current, impedance and power consumed, in a simple AC circuit by using Network Analysis theorems.**

COMPETENCIES AND EPO'S

2.14.1 COMPETENCY: **Calculate Voltage, Current, Impedance, and Power Using Thevenin's Theorem**

ENABLING PERFORMANCE OBJECTIVE

1. Given the necessary circuit values, the student will be able to calculate voltage, current, impedance and power, by using Thevenin's theorem in a simple AC circuit.

2.14.2 COMPETENCY: **Calculate Voltage, Current, Impedance, and Power Using Norton's Theorem**

ENABLING PERFORMANCE OBJECTIVE

1. Given the necessary circuit values, the student will be able to calculate voltage, current, impedance, and power, by using Norton's theorem in a simple AC circuit.

2.14.3 COMPETENCY: **Calculate voltage, current impedance and power using Superposition Theorem**

ENABLING PERFORMANCE OBJECTIVE

1. Given the necessary circuit values, the student will be able to calculate voltage, current, impedance, and power by using the Superposition Theorem in a simple AC circuit.

2.14.4 COMPETENCY: **Calculate circuit values using Kirchoff's laws**

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to use Kirchoff's current and voltage laws, as needed, analyze circuits and find circuit values in a simple AC circuit.

TASKS
PERFORMANCE OBJECTIVES
COMPETENCIES
AND
ENABLING OBJECTIVES

2.15 TASK: Calculate Conditions at Resonance in an AC Circuit

TERMINAL PERFORMANCE OBJECTIVE

1. Given the necessary circuit values at resonance, calculate the impedance, the phase angle, the circuit current, the voltage across the resistor, inductor, and capacitor, and the total power consumed by the circuit, in a series resonant circuit.
2. Given the necessary circuit values at resonance, calculate the impedance, the phase angle, the circulating current, the line current, the voltage across each of the components (including the angle), and the power consumed, in a parallel resonant circuit.
3. Calculate bandwidth, bandpass, Q, and resonant frequency, and show how series and parallel resonant circuits can be used as bandpass or bandstop (notch) filters.
4. Draw the schematic diagram of a bandpass filter.
5. Draw the schematic diagram of a bandstop filter.

COMPETENCIES AND EPO'S

2.15.1 COMPETENCY: Calculate impedance in series RLC circuits

ENABLING PERFORMANCE OBJECTIVE

The student be able to calculate the impedance of a series RLC circuit, by using either vector analysis or trigonometric formulas, to obtain the value in ohms and the angle of the impedance, for circuits that are at resonance, above the resonant frequency, or below the resonant frequency. The student will be given the necessary values of resistance, capacitance and inductance to perform the needed math, or will be given sufficient information to determine the resistance and the reactance values.

2.15.2 COMPETENCY: Calculate current flow in series RLC circuits

ENABLING PERFORMANCE OBJECTIVE

The student will be able to calculate the amount of current flowing in an RLC series circuit by using either vector analysis or trigonometric formulas, to obtain the value in amps, and the phase angle of the current, for circuits at resonance, or above or below resonance.

2.15.3 COMPETENCY: **Calculate voltage drops in series RLC circuits**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to calculate the voltage drops across the capacitor, the inductor, and the resistor, in an RLC series circuit at resonance, or above or below resonance. The student will include the angle as part of the measurement.

2.15.4 COMPETENCY: **Calculate power consumed by RLC circuits**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to calculate the reactive power, apparent power, and true power consumed by each of the components in an RLC series or parallel circuit at resonance, above resonance and below resonance.

2.15.5 COMPETENCY: **Calculate impedance of parallel RLC circuits**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to calculate the impedance of parallel RLC circuits at resonance, or above resonance or below resonance.

2.15.6 COMPETENCY: **Calculate current flow in parallel RLC circuits**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to calculate circulating current, and line current, for a parallel RLC circuit, at resonance, above resonance or below resonance, and determine the phase angle of current flow.

2.15.7 COMPETENCY: **Calculate voltage drops in parallel RLC circuits**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to calculate the amount of voltage across each component in a parallel RLC circuit, at resonance, above resonance or below resonance.

2.15.8 COMPETENCY: **Calculate frequency response in series and parallel resonant circuits**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to calculate the frequency response of a series or parallel resonant circuit, and determine the bandwidth, bandpass, Q, half power points, and 3 DB points. The student will show how the circuit can be used as a band pass or band reject filter.

2.15.9 COMPETENY: **Draw schematic diagram of a bandpass filter**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to draw the schematic diagram of a bandpass filter and show how the component values affect the frequency of operation.

2.15.10 COMPETENCY: **Draw schematic diagram of a bandstop filter**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to draw the schematic diagram of a bandstop (notch) filter, and show the relationship between component values and the frequency of operation.

TASK
PERFORMANCE OBJECTIVES
COMPETENCIES
AND
ENABLING OBJECTIVES

2.16 TASK: Calculate Circuit Values for Transformer Circuits

TERMINAL PERFORMANCE OBJECTIVE

1. **Calculate the voltage ratio from primary winding to secondary winding.**
2. **Calculate the impedance ratio of the transformer from primary winding to secondary winding.**
3. **Calculate the reflected impedance from secondary winding to primary winding.**
4. **Construct the equivalent circuit for mutually coupled transformer sections.**
5. **Describe the parameters of the circuit at resonance for a mutually coupled transformer circuit.**

COMPETENCIES AND EPO'S

2.16.1 COMPETENCY: **Calculate the voltage ratio from primary to secondary**

ENABLING PERFORMANCE OBJECTIVE

1. When given the necessary information about the transformer the student will calculate the voltage ratio from primary winding to secondary winding.

2.16.2 COMPETENCY: **Calculate impedance ratio from primary to secondary**

ENABLING PERFORMANCE OBJECTIVE

1. When given the necessary information about the transformer the student will calculate the impedance ratio of the transformer from primary winding to secondary winding.

2.16.3 COMPETENCY: **Calculate reflected impedance from secondary to primary**

ENABLING PERFORMANCE OBJECTIVE

1. When given the necessary information about the transformer and the associated circuitry, the student will be able to calculate the reflected impedance from secondary winding to primary winding.

2.16.4 COMPETENCY: **Construct equivalent circuits for mutually coupled transformer circuits**

ENABLING PERFORMANCE OBJECTIVE

1. When given the necessary information about the transformer the student will be able to analyze the circuit and construct the equivalent circuit for mutually coupled transformer sections.

2.16.5 COMPETENCY: **Describe parameters of resonant mutually coupled transformer circuits**

ENABLING PERFORMANCE OBJECTIVE

1. When given the necessary information about the transformer circuit at resonance the student will be able to analyze the circuit and describe the parameters of the circuit at resonance for a mutually coupled transformer circuit.

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AND
ENABLING OBJECTIVES

ELECTRONICS LABORATORY

IDAHO STANDARDIZED ELECTRONICS CURRICULUM

PREPARED 13 April, 1985
REVISED 9 December, 1986
BY Electronics Curriculum Committee
Area Vocational Technical Schools
State of Idaho

State of Idaho - Electronics Technology Standardized Vocational Program

PERFORMANCE STANDARDS

The following is a list of measurable performance objectives for the Electronics Laboratory portion of the standardized Electronics Technology Program for the State of Idaho Vocational Electronics Curriculum.

This listing is intended to be a simple, easy to read format of the performance standards for this portion of the course. The student, as well as the instructor, can see at a glance the tasks, terminal performance objectives, competencies, and enabling performance objectives that are necessary for completion of this section.

The following list of Conditions and Criteria are intended to be used with each of the Performance Objectives listed later in this document. Where the exact conditions cannot be met, the instructor will be responsible to insure that the purpose of the objective is accomplished, to guarantee the level of learning necessary for the success of the student.

CONDITIONS:

1. The student may use a calculator, except where specifically prohibited in the objective statement.
2. All answers to mathematical calculations must be accurate to tolerances specified by the instructor.
3. Calculations involving numbers extracted from a graph must be accurate to tolerances specified by the instructor.
4. The student will be required to list units of measurement, with the numerical answer, when the unit of measurement is an integral part of the answer, such as 5 volts, 1 ampere, or 4.7 kilohms.
5. The instructor will insure that the student is exposed to the necessary activities as many times as is needed to insure that the student not only can perform the objective once, but also can retain the knowledge to use at a later time.

CRITERIA:

1. All answers must be accurate to tolerances specified by the instructor, for mathematical solutions and graphical solutions.
2. Accomplishment of the performance objective may be tested on more than one occasion, through the use of questions on subsequent exams. (Review Questions)
3. Retention of the knowledge of the information covered by the objective may be tested at a later time on a final exam, given at the end of the session.

STANDARD TOOL BOX FOR ELECTRONICS LABORATORY

The student will provide, or be provided, (depending on local policy), a tool box containing the following items. Items in addition to this may be in the tool box, at the discretion of the instructor. Manufacturer's part numbers are included for reference only, and do not constitute an endorsement of one manufacturer over another.

Standard Screwdriver, 3/32" x 2", 1/2" handles, Xcelite #R3322

Standard Screwdriver, 4" blade, Xcelite #R184

Phillips Screwdriver, Xcelite #X101

Solder sucker, SolderPullt PT-109

Soldering Aid, GC #9069

Wire Stripper, GC #760

Diagonal Cutters, 4", Xcelite #64

Long Nose Pliers, 4", Xcelite #41, or 4 1/2", #D321 or equivalent

Soldering Pencil, 25 to 30 watt, with stand and cleaning sponge

Solder, 1/4 pound roll, 60/40 or 63/37 rosin core, 20 or 22 gauge

One set of alligator clip test leads, GC#J4-655

Non-Acid Solder Flux Paste

Circuit Board Holder or Vise

Tool Box, large enough to hold all tools and VOM or EMM type Meter, if required by instructor

STANDARD PARTS PACKAGE FOR ELECTRONICS LABORATORY

The student will be provided a standard parts package, which includes, but is not limited to, the following list of parts. It will be the responsibility of the student to use these parts with due regard for the expense involved. Depending on local policy, the student may be required to pay for the cost of replacement of parts damaged through negligence.

RESISTORS (20 % OR BETTER)

2 10 Ohm, 1/2 watt	2 33 K ohm, 1/2 watt
2 15 Ohm, 1/2 watt	2 47 K ohm, 1/2 watt
2 22 Ohm, 1/2 watt	2 68 K ohm, 1/2 watt
2 33 Ohm, 1/2 watt	4 100 K ohm, 1/2 watt
2 47 Ohm, 1/2 watt	4 150 K ohm, 1/2 watt
2 68 Ohm, 1/2 watt	2 220 K ohm, 1/2 watt
4 100 Ohm, 1/2 watt	2 330 K ohm, 1/2 watt
2 150 Ohm, 1/2 watt	2 470 K ohm, 1/2 watt
2 220 Ohm, 1/2 watt	2 680 K ohm, 1/2 watt
2 330 Ohm, 1/2 watt	2 1 M ohm, 1/2 watt
2 470 Ohm, 1/2 watt	2 1.5 M ohm, 1/2 watt
2 680 Ohm, 1/2 watt	2 2.2 M ohm, 1/2 watt
4 1000 Ohm, 1/2 watt	2 3.3 M ohm, 1/2 watt
2 1500 Ohm, 1/2 watt	2 4.7 M ohm, 1/2 watt
2 2200 Ohm, 1/2 watt	2 1 Ohm, 5 watt
2 3300 Ohm, 1/2 watt	2 2 Ohm, 5 watt
2 4700 Ohm, 1/2 watt	2 3 Ohm, 5 watt
2 6800 Ohm, 1/2 watt	2 4 Ohm, 5 watt
4 10 K ohm, 1/2 watt	2 5 Ohm, 5 watt
4 15 K ohm, 1/2 watt	2 10 Ohm, 5 watt
2 22 K ohm, 1/2 watt	2 15 Ohm, 5 watt
	2 250 Ohm, 5 watt

CAPACITORS (20% OR BETTER) (50 Volt Rating or Higher, as Noted)

1 15 pfd	1 .47 ufd (47 nfd)
1 47 pfd	1 .47 ufd @ 400 V
1 250 pfd	2 1 ufd @ 16 V
3 .001 ufd (1 nfd)	1 1 ufd @ 400 V
1 .0022 ufd (2.2 nfd)	1 4.7 ufd @ 100 V
2 .0047 ufd (4.7 nfd)	1 10 ufd @ 16 V
1 .0047 ufd (4.7 nfd) @ 400 V.	1 10 ufd @ 100 V
4 .01 ufd (10 nfd)	2 25 ufd
1 .015 ufd (15 nfd)	1 40 ufd
2 .022 ufd (22 nfd)	4 100 ufd
3 .047 ufd (47 nfd)	
1 .047 ufd (47 nfd) @ 400 V.	
4 .1 ufd (100 nfd)	
2 .1 ufd (100 nfd) @ 400 V.	

Semiconductor Devices

4 Rectifier Diodes 1N5625 or equivalent
2 Small Signal Diodes 1N914 or equivalent
2 Zener Diodes 1W, 10 Volt, 1N3020 or equivalent
2 NPN Silicon Transistors, 2N3904 or equivalent
2 PNP Silicon Transistors, 2N3906 or equivalent
2 NPN Silicon Transistors, 2N6004 or equivalent
2 PNP Silicon Transistors, 2N6005 or equivalent
2 NPN Silicon Transistors, 2N2102 or equivalent, with heat sink
1 3N187 N Channel MOSFET, or equivalent
1 LED TIL 221, or equivalent
1 LED TIL 222, or equivalent
1 LED TIL 312, or equivalent

Miscellaneous

1 Transformer, 115 VAC primary to 25 VAC secondary at 1 Amp
2 8 Hy Choke @ 50 maDC
1 30 mhy RF Choke
1 Audio Output Transformer, Kelvin 149-18 or equivalent
1 Audio Output Transformer, Kelvin 175-45 or equivalent
1 Audio Input Transformer, Kelvin 155-08 or equivalent
1 Each, Potentiometers, 500 ohm, 1 k ohm, 2.5 k ohm, 5 k ohm, 50 k ohm, and 2.5 Meg ohm
2 Each, Potentiometers, 10 k ohm, 100 k ohm, and 500 k ohm
1 PM Speaker, 3.2 ohm impedance, 1 watt or greater

NOTE: This list is only a partial list of the many components that will be necessary to complete the competencies listed in the program standards for the Electronics Laboratory. It is only a suggested list as well. The instructor will be the final authority as to which parts he/she deems necessary, based on the instructor's choice of lab manual, and individual teaching style. As long as the intent of the performance objectives is served, no conflict would occur if suitable parts are substituted.

TASKS
PERFORMANCE OBJECTIVES
COMPETENCIES
AND
ENABLING OBJECTIVES

3.1 TASK: Identify Electrical Components With Their Schematic Symbols

TERMINAL PERFORMANCE OBJECTIVE

1. Match the following components with the schematic symbols for those components:

a. Resistors	b. Caparitors	c. Inductors
d. Potentiometers	e. Rheostats	f. Transformers
g. Lamps	h. Semiconductor devices	i. Ohmmeters
j. Ammeters	k. Voltmeters	l. Switches
m. AC sources	n. DC sources	o. Relays
p. Thermistors		

2. Draw the schematic symbol for each of the listed components and list any values that would normally appear on the schematic.
3. Select the correct component from a collection of assorted components.

COMPETENCIES AND EPO'S

3.1.1 COMPETENCY: Draw resistor schematic symbol

ENABLING PERFORMANCE OBJECTIVE

The student will be able to draw the schematic symbol for a fixed resistor, potentiometer, rheostat, thermistor and adjustable resistor. All values that would be listed on the schematic diagram shall be listed; such as ohms, wattage, and/or tolerance.

3.1.2 COMPETENCY: Draw lamp schematic symbol

ENABING PERFORMANCE OBJECTIVE

The student will be able to draw the schematic symbol for a lamp and indicate on the schematic any value that would appear normally on the schematic.

3.1.3 COMPETENCY: Draw battery schematic symbol

ENABLING PERFORMANCE OBJECTIVE

The student will be able to draw the schematic symbol for a battery or other DC voltage source and label the + and - ends of the battery.

3.1.4 COMPETENCY: **Draw capacitor schematic symbols**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to draw the schematic symbol for a capacitor, both electrolytic and non-electrolytic type, and label polarity, as necessary; and any value that would normally appear on the schematic.

3.1.5 COMPETENCY: **Draw inductor schematic symbol**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to draw the schematic symbol for an inductor, both iron core and other types, and label any values that would normally appear on the schematic.

3.1.6 COMPETENCY: **Draw transformer schematic symbol**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to draw the schematic symbol for a transformer, both iron core and other types, and label any values that would normally appear on the schematic.

3.1.7 COMPETENCY: **Draw ammeter schematic symbol**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to draw the schematic symbol for an ammeter and label any values that would normally appear on the schematic.

3.1.8 COMPETENCY: **Draw voltmeter schematic symbol**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to draw the schematic symbol for a voltmeter and label any values that would normally appear on the schematic.

3.1.9 COMPETENCY: **Draw ohmmeter schematic symbol**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to draw the schematic symbol for an ohmmeter and label any values that would normally appear on the schematic.

3.1.10 COMPETENCY: **Draw AC voltage source schematic symbol**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to draw the schematic symbol for an AC voltage source and label any values that would normally appear on the schematic.

3.1.11 COMPETENCY: **Draw diode schematic symbol**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to draw the schematic symbol for a PN junction diode, zener diode, and light-emitting diode, and label any values that would normally appear on the schematic.

3.1.12 COMPETENCY: **Draw bipolar transistor schematic symbol**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to draw the schematic symbol for a PNP or NPN bipolar transistor and label the base, emitter, and collector leads, and any identifying numbers that might appear on the schematic diagram.

3.1.13 COMPETENCY: **Draw schematic symbol for FET transistors**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to draw the schematic symbol for the following field effect transistor devices and label any values or identifying numbers that would normally appear on the schematic:

1. N Channel JFET
2. P Channel JFET
3. N Channel Depletion MOSFET
4. P Channel Depletion MOSFET
5. N Channel Enhancement MOSFET
6. P Channel Enhancement MOSFET

3.1.14 COMPETENCY: **Draw switch schematic symbols**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to draw the schematic symbol for several types of switches; including SPST, SPDT, DPST, DPDT, and rotary switch, and label any values that would normally appear on the schematic.

3.1.15 COMPETENCY: **Draw schematic symbol of relay**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to draw the schematic symbol for a simple SPST relay device and label any values that would normally appear on the schematic diagram.

3.1.16 COMPETENCY: **Draw schematic symbol of thermistor**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to draw the schematic symbol for a thermistor, both positive temperature coefficient, and negative temperature coefficient, and label any values that would normally appear on the schematic diagram

3.1.17 COMPETENCY: **Match components to schematic symbols**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to read a schematic diagram and identify the components represented on the schematic. The schematic will include the components listed in the beginning of the performance objective.

3.1.18 COMPETENCY: **Choose components from schematic diagram**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to read a schematic diagram and select the correct components to match the schematic diagram, from the student's parts kit, or from components supplied by the instructor; and assemble them in series, parallel, or series-parallel combination, as the schematic shows.

TASK
PERFORMANCE OBJECTIVES
COMPETENCIES
AND
ENABLING OBJECTIVES

3.2 TASK: Construct Electronic Circuits From Electrical Components

TERMINAL PERFORMANCE OBJECTIVE

1. Prepare components for insertion into a printed circuit board, solderless breadboard, or use in point to point wiring; such as terminal strips, solder tail, or solder terminals of various types.
2. Solder components into a printed circuit board or in point to point wiring, as necessary.
3. Desolder components on printed circuit boards or in point to point wiring, for removal from the circuit.
4. Observe all safety rules for soldering and use of hand tools.

COMPETENCIES AND EPO'S

3.2.1 COMPETENCY: Use tools to form component leads

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to use the tools in the standard tool box to prepare leads of components mentioned in previous competency by cleaning, bending, and cutting as necessary, for insertion into a printed circuit board, solderless breadboard, or point to point wiring.

3.2.2 COMPETENCY: Strip and tin wire

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to demonstrate the ability to strip the insulation from a wire and tin the wire in preparation for connecting the wire between two electrical points.

3.2.3 COMPETENCY: Splice wires together

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to splice two wires together by means of a Union splice and crimping and soldering.

3.2.4 COMPETENCY: Demonstrate soldering technique

ENABLING PERFORMANCE OBJECTIVE

1. The student will use the tools in the Standard Tool Box to solder components into a printed circuit board.
2. The student will use the tools in the Standard Tool Box to solder components in point to point wiring, as necessary.

3. The student will use the tools in the Standard Tool Box to desolder components in printed circuit boards, for removal from the board.
4. The student will use the tools in the Standard Tool Box to desolder components in point to point wiring, for removal from the circuit.
5. The student will accomplish 1 through 4 above while observing all safety rules for soldering and use of hand tools.

3.2.5 COMPETENCY: **Demonstrate breadboarding technique**

ENABLING PERFORMANCE OBJECTIVE

1. The student will be given a schematic diagram of the circuit to be constructed.
2. The student will determine the proper layout of the circuit on the prototype board and/or the breadboard type of PC board.
3. The student will construct the circuit represented by the schematic diagram.

3.2.6 COMPETENCY: **Demonstrate proper handling of components**

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to demonstrate the proper handling procedures for all components listed in Performance Objective 3.1.
2. The student will handle the above listed components correctly and safely while working in the lab or other work environment.
3. The student will be able to list the necessary handling precautions, and safety procedures involved for the above listed components.

3.2.7 COMPETENCY: **Repair printed circuit boards**

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to repair a printed circuit board by replacing components, such as resistors, and repairing open or broken connections on the board.

TASK
PERFORMANCE OBJECTIVES
COMPETENCIES
AND
ENABLING OBJECTIVES

3.3 TASK: Use Electrical Test Equipment Correctly

TERMINAL PERFORMANCE OBJECTIVE

1. **Demonstrate the correct use of each piece of test equipment used in the lab.**
2. **Use each piece of test equipment safely, so that no damage occurs to the test equipment, the student, or others in the lab or other work environment.**

COMPETENCIES AND EPO'S

3.3.1 COMPETENCY: **Demonstrate use of VOM type multimeter**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to demonstrate the proper use of the VOM type multimeter by using it safely in the laboratory and obtaining the expected results in the lab assignments. The student must exercise proper care so that neither the test equipment nor any individual is in danger as a result of carelessness or disregard for the proper operation of the test equipment.

3.3.2 COMPETENCY: **Demonstrate use of DC power supplies**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to demonstrate the proper use of the DC power supply by using it safely in the laboratory and obtaining the expected results in the lab assignments. The student must exercise proper care so that neither the test equipment nor any individual is in danger as a result of carelessness or disregard for proper operation of the test equipment.

3.3.3 COMPETENCY: **Demonstrate use of audio generator**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to demonstrate the proper use of the audio generator by using it safely in the laboratory and obtaining the expected results in the lab assignments. The student must exercise proper care so that neither the test equipment nor any individual is in danger as a result of carelessness or disregard for proper operation of the test equipment.

3.3.4 COMPETENCY: **Demonstrate use of oscilloscope**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to demonstrate the proper use of the oscilloscope, both single and dual trace, by using it safely in the laboratory and obtaining the expected results in the lab assignments. The student must exercise proper care so that neither the test equipment nor any individual is in danger as a result of carelessness or disregard for proper operation of the test equipment.

3.5 COMPETENCY: **Demonstrate use of RF signal generators**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to demonstrate the proper use of the RF signal generator by using it safely in the laboratory and obtaining the expected results in the lab assignments. The student must exercise proper care so that neither the test equipment nor any individual is in danger as a result of carelessness or disregard for proper operation of the test equipment.

3.3.6 COMPETENCY: **Demonstrate use of frequency counter**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to demonstrate the proper use of the frequency counter, by using it safely in the laboratory and obtaining the expected results in the lab assignments. The student must exercise proper care so that neither the test equipment nor any individual is in danger as a result of carelessness or disregard for proper operation of the test equipment.

3.3.7 COMPETENCY: **Demonstrate use of capacitor checker**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to demonstrate the proper use of the capacitor checker, by using it safely in the laboratory and obtaining the expected results in the lab assignments. The student must exercise proper care so that neither the test equipment nor any individual is in danger as a result of carelessness or disregard for proper operation of the test equipment.

3.3.8 COMPETENCY: **Demonstrate use of electronic multimeters**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to demonstrate the proper use of the EMM type multimeter, by using it safely in the laboratory and obtaining the expected results in the lab assignments. The student must exercise proper care so that neither the test equipment nor any individual is in danger as a result of carelessness or disregard for proper operation of the test equipment.

3.3.9 COMPETENCY: **Demonstrate use of decade boxes**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to demonstrate the proper use of both the capacitive and resistive decade box by using it safely in the laboratory and obtaining the expected results in the lab assignments. The student must exercise proper care so that neither the test equipment nor any individual is in danger as a result of carelessness or disregard for proper operation of the test equipment.

3.3.10 COMPETENCY: **Demonstrate use of variac**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to demonstrate the proper use of the variac type transformer, by using it safely in the laboratory and obtaining the expected results in the lab assignments. The student must exercise proper care so that neither the test equipment nor any individual is in danger as a result of carelessness or disregard for proper operation of the test equipment.

3.3.11 COMPETENCY: **Demonstrate use of isolation transformer**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to demonstrate the proper use of the isolation transformer by using it safely in the laboratory and obtaining the expected results in the lab assignments. The student must exercise proper care so that neither the test equipment nor any individual is in danger as a result of carelessness or disregard for proper operation of the test equipment.

TASKS
PERFORMANCE OBJECTIVES
COMPETENCIES
AND
ENABLING OBJECTIVES

3.4 TASK: Troubleshoot Electrical Circuits and Components for Faulty Operation

TERMINAL PERFORMANCE OBJECTIVE

1. **Troubleshoot electrical circuits to determine the cause of faulty operation.**
2. **Troubleshoot electrical components and determine the cause of faulty operation.**

COMPETENCIES AND EPO'S

3.4.1 COMPETENCY: **Define short circuit**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to define the term 'short circuit', and determine the effect upon a circuit. The student will explain what effect a short will have on a component in terms of resistance of the component, current through a component when connected in a circuit, and voltage drop across a component when connected in a circuit.

3.4.2 COMPETENCY: **Define open circuit**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to define the term 'open circuit', and determine the effect upon a circuit. The student will explain what effect an open will have on a component in terms of resistance of the component, current through a component when connected in a circuit, and voltage drop across a component when connected in a circuit.

3.4.3 COMPETENCY: **Determine shorts, opens, using resistance readings**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to measure the resistance of any of the parts listed in performance objective 3.1, and determine whether that component is shorted, or open, or is normal, in terms of resistance readings, using a VOM type meter, or an EMM meter.

3.4.4 COMPETENCY: **Determine shorts, opens, using voltage readings**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to measure the voltage drop across any of the parts listed in performance objective 3.1, and determine whether that component may be shorted, open, or normal, in terms of voltage readings, by using a VOM type meter, or an EMM meter.

3.4.5 COMPETENCY: **Determine shorts, opens, by using current readings**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to measure the current flow through any of the parts listed in performance objective 3.1, and determine whether that component may be shorted, open, or may be normal, in terms of current readings, by using a VOM type meter, or an EMM meter.

3.4.6 COMPETENCY: **Determine out of tolerance components by using resistance readings**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to measure the resistance of resistors, inductors, potentiometers, rheostats, and other devices for which the resistance is specified, and determine whether the resistance reading falls within acceptable limits, as determined by the tolerance rating of that component.

3.4.7 COMPETENCY: **Troubleshoot series circuits for failures**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to troubleshoot a series circuit, by measuring voltages, resistance, and/or current, and determine whether the circuit is operating properly, or has a malfunction. If the circuit is determined to be faulty, to find the faulty component.

3.4.8 COMPETENCY: **Troubleshoot parallel circuits for failures**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to troubleshoot a parallel circuit, by measuring voltages, resistance, and/or current, and determine whether the circuit is operating properly, or has a malfunction. If the circuit is determined to be faulty, the student will find the faulty component.

3.4.9 COMPETENCY: **Troubleshoot series-parallel circuits for failures**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to troubleshoot series-parallel combination circuits, by measuring voltage, current, and/or resistance, and determine whether the circuit is operating properly, or has a malfunction. If the circuit is determined to be faulty, the student will find the faulty component.

TASKS
PERFORMANCE OBJECTIVES
COMPETENCIES
AND
ENABLING OBJECTIVES

3.5 TASK: Calculate and Measure Resistivity of Materials

TERMINAL PERFORMANCE OBJECTIVE

1. **Determine the resistivity of a given material.**
2. **Having determined the resistivity of the particular material, determine the expected resistance of the material.**
3. **Measure the resistance of the material in question to determine whether it is correct as calculated.**

COMPETENCIES AND EPO'S

3.5.1 COMPETENCY: **Use resistivity chart to determine resistivity of materials**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to use a chart showing the resistivity of various materials to determine the resistivity of a given material.

3.5.2 COMPETENCY: **Calculate resistance of materials**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to calculate the expected resistance of a given material by using the information obtained from a chart of resistivity.

3.5.3 COMPETENCY: **Measure resistance by using VOM**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to measure the resistance of a given material, by using a VOM meter and verify whether expected resistance is correct as determined in the previous competency.

3.5.4 COMPETENCY: **Measure resistance by using EMM**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to measure the resistance of a given material, by using an EMM meter, and verify whether expected resistance is correct as determined in the previous competency.

TASKS
PERFORMANCE OBJECTIVES
COMPETENCIES
AND
ENABLING OBJECTIVES

3.6 TASK: Measure Resistance Indirectly, By using Other Circuit Values

TERMINAL PERFORMANCE OBJECTIVE

1. **Calculate the resistance of a circuit, as well as the current and voltage drops in the circuit.**
2. **Measure the voltage drops in the circuit and the current in the circuit.**
3. **Use the above calculations and measurements to indirectly obtain the resistance in the circuit.**

COMPETENCIES AND EPO'S

3.6.1 COMPETENCY: **Calculate resistance of circuit**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to calculate the resistance of a series-parallel circuit, by using Ohm's law or one of the network theorems.

3.6.2 COMPETENCY: **Calculate current flow in circuit**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to calculate the amount of current flowing in a series-parallel circuit, by using Ohm's law or one of the network theorems; such as Thevenins theorem or Norton's theorem.

3.6.3 COMPETENCY: **Calculate voltage drops in circuit**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to calculate the voltage drops in a series-parallel circuit, by using Ohm's law or one of the network theorems; such as Thevenin's theorem or Norton's theorem.

3.6.4 COMPETENCY: **Measure voltage drops in circuit**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to measure the voltage drops around the circuit, for a series-parallel circuit, by using either an analog type multimeter or a digital type multimeter.

3.6.5 COMPETENCY: **Measure current flow in circuit**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to measure the current flowing through each component in a series-parallel circuit, by using either an analog type multimeter, or a digital type multimeter.

3.6.6 COMPETENCY: **Calculate resistance by using measured circuit values**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to calculate the resistance at any point in a series-parallel circuit, by using the measured values of current and voltage, obtained through the use of the multimeter.

TASKS
PERFORMANCE OBJECTIVES
COMPETENCIES
AND
ENABLING OBJECTIVES

3.7 TASK: Verify Network Theorems by Measuring Voltage, Current and Resistance

TERMINAL PERFORMANCE OBJECTIVE

1. Construct a series-parallel circuit in accordance with a schematic diagram.
2. Calculate circuit values by using Kirchoff's current law.
3. Calculate circuit values by using Kirchoff's voltage law.
4. Measure circuit values to verify Kirchoff's current and voltage laws.
5. Calculate circuit values of R_{TH} and V_{TH} by using Thevenin's theorem.
6. Measure circuit values to verify accuracy of calculations of R_{TH} and V_{TH}.
7. Calculate circuit values by using Norton's theorem.
8. Measure circuit values to verify accuracy of calculations by using Norton's theorem.

COMPETENCIES AND EPO'S

3.7.1 COMPETENCY: Calculate and measure values for Kirchoff's current law

ENABLING PERFORMANCE OBJECTIVE

The student will be able to construct a series-parallel circuit, by using schematic diagram supplied by the instructor, or taken from the lab manual, and calculate the expected current flow through each component, by using Kirchoff's current law. The student will then connect a multimeter, (either analog or digital) and measure the current through each component. The student will list any discrepancies between current flow calculated and current measured in the circuit.

3.7.2 COMPETENCY: Calculate and measure values for Kirchoff's voltage law

ENABLING PERFORMANCE OBJECTIVE

The student will be able to construct a series-parallel circuit, by using schematic diagram supplied by the instructor, or taken from the lab manual, and calculate the expected voltage drops across each component, by using Kirchoff's voltage law. The student will then connect a multimeter, (either analog or digital) and measure the voltage across each conmponent. The student will any discrepancies between voltage drops calculated and voltage measured in the circuit.

3.7.3 COMPETENCY: **Calculate and measure values for Thevenin's theorem**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to construct a series-parallel circuit, using a schematic diagram supplied by the instructor or taken from the lab manual, and calculate the expected Thevenin equivalent resistance and Thevenin voltage (open circuit voltage), by using Thevenin's theorem. The student will then connect a multimeter, (either analog or digital) and measure the equivalent resistance and open circuit voltage. The student will list any discrepancies between equivalent resistance measured, open circuit voltage measured and calculated values.

3.7.4 COMPETENCY: **Calculate and measure values for Norton's theorem**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to construct a series-parallel circuit, using a schematic diagram supplied by the instructor or taken from the lab manual, and calculate the expected current flow through the selected load, short circuit current (Norton's current), and Norton's equivalent resistance, by using Norton's Theorem. The student will then connect a multimeter, (either analog or digital) and measure the current through the load to verify Norton's theorem. The student will list any discrepancies between current flow calculated and current measured in the circuit. Note: Student will not be required to measure the short circuit current, unless the instructor verifies that the circuit will not be damaged by short circuiting the load.

TASK
PERFORMANCE OBJECTIVES
COMPETENCIES
AND
ENABLING OBJECTIVES

3.8 TASK: Measure Loading Effects of Multimeter

TERMINAL PERFORMANCE OBJECTIVE

1. Construct a circuit of components that are small enough in value to seriously affect the accuracy of the meter readings on the analog multimeter.
2. Calculate the value of current flow throughout the circuit.
3. Measure the actual current flowing in the circuit in question and compare to the expected results.
4. Determine the amount of effect the meter has on the accuracy of the test readings.
5. Perform this task with meters of different sensitivities and on different scales on each meter.
6. Construct a circuit with components that are large enough to seriously affect the accuracy of the readings on the analog multimeter.
7. Calculate the expected voltage drops in the circuit.
8. Measure the voltage drops in the circuit and compare them to the expected results.
9. Determine the amount of effect the meter has on the accuracy of the test readings.
10. Perform this task with meters of different sensitivities and on different scales of each meter.

COMPETENCIES AND EPO'S

3.8.1 COMPETENCY: Calculate and measure resistance, voltage, and current using analog multimeter

ENABLING PERFORMANCE OBJECTIVE

The student will
1. construct a circuit in accordance with a schematic diagram or other information given to the student;
2. calculate the expected voltage drops, current flow and resistance in the circuit; and
3. measure the circuit values with an analog multimeter.

3.8.2 COMPETENCY: Measure insertion effect on low Z circuit

ENABLING PERFORMANCE OBJECTIVE

The student will
1. construct a circuit in accordance with a schematic diagram provided by the instructor, or other information provided by the instructor; (This circuit will consist of components that are small enough in value to seriously affect the accuracy of the meter readings on the analog multimeter)

2. calculate the value of current flow throughout the circuit;
3. measure the actual current flowing in the circuit in question and compare values to the expected results;
4. mathematically determine the amount of effect the meter has on the accuracy of the test readings, and recalculate the expected readings, taking into account the resistance of the meter;
5. perform this task with meters of different sensitivities and on different scales on each meter.

3.8.3 COMPETENCY: **Measure loading effect of meter on high impedance circuits**

ENABLING PERFORMANCE OBJECTIVE

The student will

1. construct a circuit in accordance with a schematic diagram provided by the instructor, or other information provided by the instructor; (The circuit will consist of components that are large enough to seriously affect the accuracy of the readings on the analog multimeter)
2. calculate the expected voltage drops in the circuit;
3. measure the actual voltage drops in the circuit and compare them to the expected results;
4. mathematically determine the amount of effect the meter has on the accuracy of the test readings, and recalculate the expected readings, taking into account the resistance of the meter;
5. perform this task with meters of different sensitivities and on different scales of each meter.

TASKS
PERFORMANCE OBJECTIVES
COMPETENCIES
AND
ENABLING OBJECTIVES

3.9 TASK: Construct Maximum Power Transfer Curve

TERMINAL PERFORMANCE OBJECTIVE

1. **Calculate the power consumed by the load resistor in a DC series circuit for several values of load resistor.**
2. **Plot the values of power on rectangular graph paper.**
3. **Determine the point at which the maximum amount of power is delivered to the load resistor.**

COMPETENCIES AND EPO'S

3.9.1 COMPETENCY: **Measure power using ammeter and voltmeter**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to measure the power dissipated by the load resistor in a simple DC series circuit consisting of two resistors, one representing the internal resistance of a source, and the other, the load resistor. The student will use an ammeter to measure the current through the load resistor, and a voltmeter to measure the voltage across the resistor.

3.9.2 COMPETENCY: **Measure load power for several values of load resistor**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to measure the power dissipated by the load resistor in a simple series DC circuit for several different values of load resistor (at least 20 values), including the value which will make $R_L=R_{int}$, and record these values on a table of values of power dissipated by the load.

NOTE: R_{int} may be considered to be the value of a resistor which is placed in series with the power supply, providing that the actual resistance of the power supply is small in comparison to the resistor in series.

3.9.3 COMPETENCY: **Construct graph of load power vs. load resistor**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to construct a graph of the values of load power determined in the competency previous to this, and compare the power dissipated by the load to the size of the load resistor, to the size of the resistance of the source of power. The student will make a statement concerning the maximum transfer of power to the load, and maximum efficiency of the circuit.

TASKS
PERFORMANCE OBJECTIVES
COMPETENCIES
AND
ENABLING OBJECTIVES

3.10 TASK: Verify Circuit Values for RC and RL Circuits Under Transient Conditions

TERMINAL PERFORMANCE OBJECTIVE

1. **Construct a graph of time versus voltage and time versus current for both series and parallel RL and RC circuits.**
2. **Identify the five time constants on the graph.**
3. **Write the values on the graph in percentage form.**
4. **Verify the value of voltage or current at any point in time.**
5. **Inject a square wave signal into the differentiator circuit, and observe the output signal.**
6. **Inject a square wave signal into the integrator circuit, and observe the output signal.**

COMPETENCIES AND EPO'S

3.10.1 COMPETENCY: **Construct time constant graph for RC and RL circuits**

ENABLING PERFORMANCE OBJECTIVE

The student will
1. construct a graph of time versus voltage and time versus current, for both series and parallel RL and RC circuits;
2. identify the five time constants on the graph;
3. write the values on the graph in percentage form; and
4. determine the voltage and current at any given point in time.

3.10.2 COMPETENCY: **Measure circuit values in an RC circuit under transient conditions**

ENABLING PERFORMANCE OBJECTIVE

The student will
1. construct a circuit in accordance with a schematic diagram or other information provided by the instructor, or found in the student lab manual, or the student may be provided with a test circuit to be used with this lab objective;
3. calculate all necessary values before taking voltage, current or resistance readings on the circuit; and
4. follow the procedure necessary to determine the charge and discharge rate of voltage and current values.

3.10.3 COMPETENCY: **Use graph to verify energy storage**

ENABLING PERFORMANCE OBJECTIVE

The student will

1. construct a circuit in accordance with a schematic diagram or other information provided by the instructor, or found in the student lab manual; or the student may be provided with a test circuit to be used with this lab objective;
3. calculate all necessary values before taking voltage, current or resistance readings on the circuit;
4. measure the value of voltage at specific time intervals as called for by the lab manual or other information provided by the instructor; and
5. construct a graph of voltage versus time, for the RC circuit under test, using the values extracted from the circuit in the operations above.

3.10.4 COMPETENCY: **Measure response of differentiator circuits to pulse input**

ENABLING PERFORMANCE OBJECTIVE

The student will

1. construct a circuit in accordance with a schematic diagram or other information provided by the instructor, or found in the student lab manual; or the student may be provided with a test circuit to be used with this lab objective;
3. calculate all necessary values before taking voltage or current readings on the circuit;
4. inject a square wave signal (using the square wave function on the signal generator) into a differentiator circuit and observe the output signal;

3.10.5 COMPETENCY: **Measure response of integrator circuits to pulse input**

ENABLING PERFORMANCE OBJECTIVE

The student will

1. construct a circuit in accordance with a schematic diagram, or other information provided by the instructor, or found in the student lab manual; or the student may be provided with a test circuit to be used with this lab objective;
3. calculate all necessary values before taking voltage or current readings in the circuit;
4. inject a square wave signal into the integrator circuit (using the square wave function on the signal generator), and observe the output signal.

TASKS
PERFORMANCE OBJECTIVES
COMPETENCIES
AND
ENABLING OBJECTIVES

3.11 TASK: Verify Conservation of Power in Passive Circuits

TERMINAL PERFORMANCE OBJECTIVE

1. **Construct a circuit in accordance with a schematic diagram or other information provided by the instructor.**
2. **Calculate amount of power consumed by the circuit and the amount of power consumed by the individual components.**
3. **Measure the necessary circuit values to determine amount of power consumed by the circuit and consumed by the individual components.**
4. **Verify that input power equals power consumed by the individual components.**

COMPETENCIES AND EPO'S

3.11.1 COMPETENCY: **Calculate power consumed by each component**

ENABLING PERFORMANCE OBJECTIVE

The student will

1. construct a circuit in accordance with a schematic diagram or other information provided by the instructor ;
2. calculate the expected current through each component, and the voltage drop across each component;
3. calculate the amount of power consumed by the individual components.

3.11.2 COMPETENCY: **Calculate total power consumed by the circuit**

ENABLING PERFORMANCE OBJECTIVE

The student will

1. calculate the total current in the circuit and the total voltage applied to the circuit;
2. determine the amount of power consumed by the circuit, from the values calculated above.

3.11.3 COMPETENCY: **Measure circuit values of current and voltage**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to

1. measure the current through each component and the current supplied by the source; and
2. measure the voltage drop across each component and the total voltage supplied by the source.

3.11.4 COMPETENCY: **Verify conversation of power**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to

1. determine the amount of power consumed by the circuit and consumed by the individual components, using the values obtained;
2. compare the expected results with the measured results to verify that the amount of power supplied to the circuit equals the amount of power consumed by the individual components in the circuit.

TASKS
PERFORMANCE OBJECTIVES
COMPETENCIES
AND
ENABLING OBJECTIVES

3.12 TASK: Construct a Meter Scale Multiplier for Voltage and Current Measurement

TERMINAL PERFORMANCE OBJECTIVE

1. **Install the value of multiplier resistor necessary to extend the voltage range of the meter to a value not presently offered on the front panel of the meter.**
2. **Measure a voltage with the meter that will verify that the meter range has been extended.**
3. **Install the value of shunt resistor necessary to extend the current range of the meter to a value not presently offered on the front panel of the meter.**
4. **Measure a current value with the meter that will verify that the meter range has been extended.**

COMPETENCIES AND EPO'S

3.12.1 COMPETENCY: **Determine sensitivity of meter**

ENABLING PERFORMANCE OBJECTIVE

1. The student will measure the amount of current flow necessary to produce full scale deflection of the meter .
2. The student will determine the sensitivity of the VOM meter using the information obtained.

3.12.2 COMPETENCY: **Calculate value of multiplier resistor for voltage scale**

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to calculate the value of multiplier resistor necessary to extend the voltage range of the meter to a value not presently offered on the front panel of the meter.

3.12.3 COMPETENCY: **Measure known value of voltage on extended voltage scale**

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to select the correct value of multiplier resistor and install in the test lead of the meter.
2. The student will be able to measure a known voltage with the meter that will verify that the meter range has been extended.

3.12.4 COMPETENCY: **Calculate value of shunt resistor for current scale**

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to calculate the value of shunt resistor necessary to extend the current range of the meter to a value not presently offered on the front panel of the meter.

3.12.5 COMPETENCY: **Measure known value of current on extended current scale**

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to select the correct value of shunt resistor and connect it between the meter leads.
2. The student will be able to measure a known current value with the meter that will verify that the meter range has been extended.

TASKS
PERFORMANCE OBJECTIVES
COMPETENCIES
AND
ENABLING OBJECTIVES

3.13 TASK: Use Test Equipment to Analyze Sinusoidal Voltages

TERMINAL PERFORMANCE OBJECTIVE

1. **Use the oscilloscope to measure and record the peak to peak voltage, and the period of a sinusoidal waveform.**
2. **Calculate the peak voltage, frequency, average voltage and RMS voltage, by using the information obtained with the oscilloscope.**
3. **Use the digital multimeter to measure and record the RMS voltage of a sinusoidal waveform.**
4. **Use the analog multimeter to measure and record the RMS voltage of a sinusoidal waveform.**
5. **Calculate the value of peak voltage, average voltage, and peak to peak voltage of a sinusoidal waveform, when the RMS value is known.**
6. **Measure the phase of an unknown signal compared to a reference signal, by using a dual trace oscilloscope.**
7. **Measure the phase of an unknown signal compared to a reference signal by using the external triggering function of the oscilloscope.**

COMPETENCIES AND EPO'S

3.13.1 COMPETENCY: **Determine frequency and voltage using the oscilloscope**

ENABLING PERFORMANCE OBJECTIVE

1. The student will use the oscilloscope to measure and record the peak to peak voltage and period of a sinusoidal waveform.
2. The student will calculate the peak voltage, frequency, average voltage, and RMS voltage by using the information obtained with the oscilloscope.

3.13.2 COMPETENCY: **Measure voltage with digital meter**

ENABLING PERFORMANCE OBJECTIVE

1. The student will use the digital multimeter to measure and record the RMS voltage of a sinusoidal waveform.

3.13.3 COMPETENCY: **Measure voltage with analog meter**

ENABLING PERFORMANCE OBJECTIVE

1. The student will use the analog multimeter to measure and record the RMS voltage of a sinusoidal waveform.
2. The student will use the true RMS reading meter to measure and record the RMS voltage of a sinusoidal waveform.

3.13.4 COMPETENCY: **Measure phase using dual trace oscilloscope**

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to measure the phase of an unknown signal to a known reference signal by using a dual trace oscilloscope.
2. The student will hook up the reference signal source to one of the two channels of the oscilloscope.
3. The student will hook up the unknown signal source to the other channel of the oscilloscope.

3.13.5 COMPETENCY: **Measure phase of unknown signal using external triggering of oscilloscope**

ENABLING PERFORMANCE OBJECTIVE

1. The student will measure the phase of an unknown signal using the external triggering function of the oscilloscope.
2. The student will hook up the reference signal generator to the external trigger (same as external sync) input on the scope, while the signal to be determined is connected to the vertical signal input on the scope.
3. Using the reference signal to trigger (synchronize) the oscilloscope, the student will be able to determine the phase relationship of the unknown signal to the reference signal.

TASKS
PERFORMANCE OBJECTIVES
COMPETENCIES
AND
ENABLING OBJECTIVES

3.14 TASK: Construct and Measure Circuit Values for a Passive, High Pass or Low Pass RC Filter Network

TERMINAL PERFORMANCE OBJECTIVE

1. Construct a circuit consisting of a low pass passive filter and a high pass passive filter.
2. Calculate all necessary values before taking voltage or current readings on the circuit.
3. Connect the low pass filter to a variable frequency generator; measure the input and output voltage at several specified frequencies, and record the readings.
4. Transfer the readings obtained to a graph; construct a Bode plot of the frequency response of the filter.
5. Repeat the procedure for the high pass filter and compare the results of the two filter networks.
6. Show phase relationships between input and output, at the specified frequencies assigned, by using the input as the reference.
7. Demonstrate the effects of adding a filter stage in cascade with the original stage. Express the output of the second stage as a DB number for several specified frequencies.

COMPETENCIES AND EPO'S

3.14.1 COMPETENCY: Calculate circuit values in an RC circuit

ENABLING PERFORMANCE OBJECTIVE

The student will be able to

1. Construct a circuit in accordance with a schematic diagram or other information provided by the instructor, or found in the student lab manual, or the student may be provided with a test circuit of a series RC circuit, to be used with this lab objective,
2. calculate all necessary values before taking voltage, current or resistance readings on the circuit,
3. use VOM and oscilloscope for voltage measurements in the circuit, with various frequencies, as specified, and record the results, and
4. calculate the current flow in the circuit based on the readings obtained and compare the results of calculations to the observed measurements with the VOM and oscilloscope.

3.14.2 COMPETENCY: **Analyze low pass filter circuit**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to

1. construct a circuit, in accordance with a schematic diagram or other information provided by the instructor, or found in the student lab manual, or the student may be provided with a test circuit, consisting of a low pass passive filter, and a high pass passive filter, to be used with this lab objective,
2. calculate all necessary values before taking voltage or current readings on the circuit,
3. connect the low pass filter to a variable frequency generator and measure the input and output voltage at several frequencies, specified by the instructor, or by the lab manual; record the readings, and
4. transfer the readings obtained to a graph, to construct a Bode plot of the frequency response of the filter.

3.14.3 COMPETENCY: **Analyze high pass filter circuit**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to

1. construct a circuit, in accordance with a schematic diagram or other information provided by the instructor, or found in the student lab manual, or the student may be provided with a test circuit, consisting of a low pass passive filter, and a high pass passive filter, to be used with this lab objective,
2. calculate all necessary values before taking voltage or current readings on the circuit,
3. connect the high pass filter to a variable frequency generator, and measure the input and output voltage at several frequencies, specified by the instructor, or by the lab manual; record the readings,
4. transfer the readings obtained to a graph, to construct a Bode plot of the frequency response of the filter, and
5. compare the results of the two filter networks.

3.14.4 COMPETENCY: **Determine phase relationships in low pass filter circuits**

ENABLING PERFORMANCE OBJECTIVE

1. From the information gathered, the student will be able to show phase relationships between input and output, in a low pass filter network, at the specified frequencies assigned, by using the input as the reference.

3.14.5 COMPETENCY: **Determine phase relationships in high pass filter circuits**

ENABLING PERFORMANCE OBJECTIVE

1. From the information gathered, the student will be able to show phase relationships between input and output, in a high pass filter network, at the specified frequencies assigned, by using the input as the reference.

3.14.6 COMPETENCY: **Demonstrate effects of cascading filter networks**

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to demonstrate the effects of adding a filter stage in cascade with the original stage. The student will be able to express the output of the second stage as a DB number, for several specified frequencies.

TASKS
PERFORMANCE OBJECTIVES
COMPETENCIES
AND
ENABLING OBJECTIVES

3.15 TASK: Measure Voltages and Calculate Current in a Series RL Circuit Under AC Conditions

TERMINAL PERFORMANCE OBJECTIVE

1. **Construct a circuit consisting of a resistor and a coil in series with each other and powered by a source of AC current, with variable frequency output.**
2. **Calculate all necessary values before taking voltage, current or resistance readings on the circuit.**
3. **Use analog multimeter to measure the voltage in the circuit, using various frequencies, and record the results.**
4. **Use the oscilloscope to measure the voltage in the circuit, using various frequencies, and record the results.**
5. **Calculate the current flow through the circuit using the measured values from the circuit.**
6. **Compare the calculated results with the measured results.**

COMPETENCIES AND EPO'S

3.15.1 COMPETENCY: **Measure voltage with analog meter**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to

1. construct a circuit, in accordance with a schematic diagram, or other information provided by the instructor, or found in the student lab manual, or the student may be provided with a test circuit to be used with this lab objective;
2. calculate all necessary values before taking voltage, current or resistance readings on the circuit,
3. use an analog multimeter to measure the voltage in the circuit with an AC generator connected to the circuit, by using various frequencies, as specified by the instructor, or the lab manual, and record the results.
   NOTE: The frequency applied to the circuit must be within the frequency range of the meter. Otherwise, the meter will not respond, or will be inaccurate, at best.

3.15.2 COMPETENCY: **Measure voltages with oscilloscope**

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to construct a circuit, in accordance with a schematic diagram, or other information provided by the instructor, or found in the student lab manual, or
2. The student may be provided with a test circuit, to be used with this lab objective.
3. The student will calculate all necessary values before taking voltage, current or resistance readings on the circuit.
4. The student will use an oscilloscope to measure the voltage in the circuit, with an AC generator connected to the circuit, by using various frequencies, as specified by the instructor, or the lab manual, and record the results.

3.15.3 COMPETENCY: **Calculate current flow using measured values**

ENABLING PERFORMANCE OBJECTIVE

1. The student will calculate the current flow through the circuit, by using the measured values of voltage, and calculated values of inductive reactance, and impedance, from the circuit.
2. The student will compare the calculated results with the measured results.

TASK
PERFORMANCE OBJECTIVES
COMPETENCIES
AND
ENABLING OBJECTIVES

3.16 TASK: Construct and Measure Circuit Values for a Series Resonant Circuit and a Parallel Resonant Circuit

TERMINAL PERFORMANCE OBJECTIVE

1. **Construct a series resonant circuit and a parallel resonant circuit.**
2. **Calculate all necessary values of voltage, current or resistance readings in the circuit.**
3. **Apply the correct frequency to the circuit to cause the condition of resonance.**
4. **Measure the voltage across each component in the circuit.**
5. **Verify that the formula used to determine the correct frequency applied to the circuit is valid.**
6. **Calculate the Q of the circuit.**
7. **Construct a graph of frequency versus output voltage for the series circuit.**
8. **Identify the half power points, the resonant point, the bandwidth of the circuit, and the bandpass from F1 to F2 on the graph.**
9. **Repeat procedure for parallel resonant circuit, making a graph of frequency versus impedance of the tank circuit.**

COMPETENCIES AND EPO'S

3.16.1 COMPETENCY: **Measure circuit values for series resonant circuit**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to

1. construct a circuit, in accordance with a schematic diagram, or other information provided by the instructor, or found in the student lab manual,
2. calculate all necessary values before taking voltage, current or resistance readings on the circuit,
3. apply the correct frequency to the circuit to cause the condition of resonance,
4. measure the voltage across each component in the circuit,
5. verify that the formula used to determine the correct frequency applied to the circuit is valid, from the information obtained.

3.16.2 COMPETENCY: **Measure circuit values for parallel resonant circuit**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to

1. construct a circuit, in accordance with a schematic diagram, or other information provided by the instructor, or found in the student lab manual,
2. calculate all necessary values before taking voltage, current or resistance readings on the circuit,
3. apply the correct frequency to the circuit to cause the condition of resonance,
4. measure the line current in the circuit,
5. calculate the impedance of the tank circuit, and verify that the formula used to determine the correct frequency applied to the circuit is valid.

3.16.3 COMPETENCY: **Construct a frequency response curve for a series resonant circuit**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to

1. measure the voltage output of a series resonant circuit, across the coil or the capacitor, at several frequencies (above and below resonance),
2. construct a graph of frequency versus output voltage, containing each of the values measured above, and
3. identify the half power points, the resonant point, the bandwidth and bandpass of the circuit.

   NOTE: Unless the coil used is an extremely high Q coil at the frequencies used, the voltage across it will actually be voltage across the coil's inductive reactance and the resistance of the coil. Therefore, it is advisable to measure the voltage across the capacitor instead, to get the most pronounced results.

3.16.4 COMPETENCY: **Construct a frequency response curve for a parallel resonant circuit**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to

1. measure the line current of a parallel resonant circuit, at several frequencies (above and below resonance),
2. construct a graph of frequency versus line current, and frequency versus impedance of the tank circuit,
3. identify the half power points, the resonant point, and the bandwidth and bandpass of the circuit.

TASK
PERFORMANCE OBJECTIVES
COMPETENCIES
AND
ENABLING OBJECTIVES

3.17 TASK: Determine Operating Characteristics in Transformer Circuits

TERMINAL PERFORMANCE OBJECTIVE

1. **Calculate all necessary values before taking voltage, current or resistance readings on the circuit.**
2. **Measure the output voltage as well as the input voltage.**
3. **Using the information obtained previously, calculate the turns ratio and impedance ratio of the transformer under test.**
4. **Measure the effect of an increase or decrease in load current on primary current.**
5. **Using resistance tests, determine whether the transformer is good or bad.**

COMPETENCIES AND EPO'S

3.17.1 COMPETENCY: **Measure input and output voltages in transformer circuits**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to

1. construct a circuit, in accordance with a schematic diagram, or other information provided by the instructor, or found in the student lab manual,or the student may be provided with a test circuit to be used with this lab objective,
2. calculate all necessary values before taking voltage readings on the circuit,
3. measure the output voltage as well as the input voltage.

3.17.2 COMPETENCY: **Determine turns ratio of transformer**

ENABLING PERFORMANCE OBJECTIVE

1. The student will measure the output voltage, as well as the input voltage, as described previously,
2. Using the information obtained, the student will calculate the turns ratio of the transformer under test.

3.17.3 COMPETENCY: **Determine impedance ratio of transformer**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to

1. determine the turns ratio of the transformer as previously described,
2. using the information obtained, calculate the impedance ratio of the transformer under test.

3.17.4 COMPETENCY: **Measure effect of load current on primary current**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to

1. connect a transformer to a load resistor and measure the voltage across the resistor,
2. determine the load current by using the voltage across the load, and the resistance of the load resistor,
3. measure the current in the primary of the transformer,
4. change the value of the load resistor (higher or lower) and determine the effect on load current and primary current.

3.17.5 COMPETENCY: **Use ohmmeter to test transformers**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to

1. measure the resistance of each of the windings of a transformer to determine whether the winding is open, shorted, or normal,
2. measure the resistance between windings on a transformer to determine whether the windings are shorted together,
3. measure the resistance of each winding to the case of the transformer to determine whether the winding is shorted to the case of the transformer, or shorted to ground.

TASKS
PERFORMANCE OBJECTIVES
COMPETENCIES
AND
ENABLING OBJECTIVES

3.18 TASK: Plot the Characteristic Curve of a PN Junction Diode and a Zener Diode

TERMINAL PERFORMANCE OBJECTIVE

1. **Measure the current through a PN junction diode and the voltage across the diode for several test values.**
2. **Make a graph of current versus voltage for the PN junction diode.**
3. **Determine the AC resistance of the diode by using a load line drawn on the graph.**
4. **Determine the reverse saturation current (leakage current) of the diode.**
5. **Measure the current through the zener diode and the voltage across the zener diode, for several test values.**
6. **Make a graph of current versus voltage for the zener diode.**
7. **Determine the zener voltage, or reverse breakdown voltage, for the zener diode, from the graph.**
8. **calculate the zener impedance of the zener diode, using information obtained from the graph.**
9. **Calculate the 20% and 90% zener current points from the graph.**

COMPETENCIES AND EPO'S

3.18.1 COMPETENCY: **Plot characteristic curve for junction diode**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to

1. construct a test circuit for controlling the voltage applied and the current through a junction diode, or be able to determine how to hook up the junction diode to a test circuit provided by the instructor,
2. connect the diode to be tested to the circuit,
3. measure the current through the diode and the voltage across the diode for several test values specified by the instructor, or the lab manual, and
4. make a graph of current versus voltage for the junction diode.

3.18.2 COMPETENCY: **Determine the AC resistance of junction diode**

ENABLING PERFORMANCE OBJECTIVE

1. Using the graph, the student will be able to draw a load line for the junction diode, for the circuit given

by the instructor, or found in the lab manual.

2. From the load line, the student will be able to determine the AC resistance of the diode.

3.18.3 COMPETENCY: **Determine reverse saturation current of diode**

ENABLING PERFORMANCE OBJECTIVE

1. Using the information obtained from the graph, the student will be able to determine the reverse saturation current of the diode.

3.18.4 COMPETENCY: **Plot characteristic curve of zener diode**

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to construct a test circuit for testing the zener diode, or will be able to hook up the zener diode to the test circuit provided by the instructor.
2. The student will be able to connect the zener diode to the test circuit,
3. measure current through the diode, and voltage across the zener diode, for several test values specified by the instructor, or the lab manual, and
4. make a graph of current versus voltage for the zener diode.

3.18.5 COMPETENCY: **Determine zener voltage**

ENABLING PERFORMANCE OBJECTIVE

1. From the information obtained from the graph, the student will be able to determine the zener voltage, or reverse breakdown voltage.

3.18.6 COMPETENCY: **Determine zener impedance**

ENABLING PERFORMANCE OBJECTIVE

1. Using the information obtained from the graph, the student will be able to calculate the zener impedance of the diode.

3.18.7 COMPETENCY: **Calculate zener current points**

ENABLING PERFORMANCE OBJECTIVE

1. Using the information obtained from the graph, the student will be able to calculate the 20% and 90% zener current points.

TASKS
PERFORMANCE OBJECTIVES
COMPETENCIES
AND
ENABLING OBJECTIVES

3.19 TASK: Construct and Measure Power Supply Circuit Values

TERMINAL PERFORMANCE OBJECTIVE

1. **Construct a half-wave, full wave center tapped, full wave bridge, and split full wave type power supply.**
2. **Calculate the values of all currents and voltages obtainable, by using the values of the components in the circuit.**
3. **Measure and record all circuit values obtainable for the four power supply circuits listed above.**
4. **Compare the expected readings to the actual readings obtained.**
5. **List advantages of each of the four circuits tested.**
6. **Measure circuit values in the voltage doubler circuit.**
7. **Observe waveforms at the input and output, by using the oscilloscope.**
8. **Determine output voltage (DC), ripple voltage, and ripple frequency.**

COMPETENCIES AND EPO'S

3.19.1 COMPETENCY: **Analyze half wave power supply**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to

1. construct a half-wave power supply,
2. calculate the values of all currents and voltages obtainable, by using the values of the components in the circuit,
3. measure and record all voltages and currents obtainable, or all voltages and currents specified by the instructor, or called for by the lab manual,
4. compare the expected readings to the actual readings obtained, and
5. list a minimum of 1 advantage of the half-wave power supply.

3.19.2 COMPETENCY: **Analyze full wave center-tapped power supply**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to

1. construct a full-wave center tapped power supply,
2. calculate the values of all currents and voltages obtainable, by using the values of the components in the circuit,
3. measure and record all voltages and currents obtainable, or all voltages and currents specified by

the instructor, or called for by the lab manual, and
4. compare the expected readings to the actual readings obtained.
5. The student will list a minimum of 1 advantage of the full-wave center-tapped power supply.

3.19.3 COMPETENCY: **Analyze full wave bridge power supply**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to
1. construct a full wave bridge rectifier power supply,
2. calculate the values of all currents and voltages obtainable, by using the values of the components in the circuit,
3. measure and record all voltages and currents obtainable, or all voltages and currents specified by the instructor, or called for by the lab manual, and
4. compare the expected readings to the actual readings obtained.
5. The student will be able to list a minimum of 1 advantage of the full wave bridge power supply.

3.19.4 COMPETENCY: **Analyze full-wave split-supply**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to
1. construct a full wave split supply type power supply,
2. calculate the values of all currents and voltages obtainable, by using the values of the components in the circuit,
3. measure and record all voltages and currents obtainable, or all voltages and currents specified by the instructor, or called for by the lab manual, and
4. compare the expected readings to the actual readings obtained.
5. From the information obtained, the student will be able to list a minimum of 1 advantage of the full wave split supply.

3.19.5 COMPETENCY: **Analyze half-wave voltage doubler**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to
1. construct a half-wave voltage doubler circuit, in accordance with a schematic diagram, or other information provided by the instructor, or found in the student lab manual, or
2. the student may be provided with a test circuit, to be used with this lab objective;
3. calculate all necessary values before taking voltage, current or resistance readings on the circuit,

4. measure the voltage across all components in the voltage doubler circuit and measure, directly or indirectly, the current through each component; (the student will also observe the waveforms at the input and output, using the oscilloscope)
5. from the information gathered, determine output voltage (DC), ripple voltage, and ripple frequency.

TASKS
PERFORMANCE OBJECTIVES
COMPETENCIES
AND
ENABLING OBJECTIVES

3.20 TASK: Construct and Measure Circuit Values in a Zener Diode Regulator Circuit

TERMINAL PERFORMANCE OBJECTIVE

1. **Construct the test circuit specified.**
2. **Calculate all values of current and voltage.**
3. **Measure and record all values of current and voltage obtainable.**
4. **Calculate the percentage of voltage regulation of the zener diode regulator circuit.**
5. **Calculate the maximum load conditions for the zener diode regulator circuit.**
6. **Compare the measured readings with the expected readings.**
7. **Measure the effects of line and load changes.**

COMPETENCIES AND EPO'S

3.20.1 COMPETENCY: **Test a zener diode with ohmmeter**

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to test a zener diode with an ohmmeter and measure the front to back ratio of resistance to determine the condition of the diode.

3.20.2 COMPETENCY: **Calculate percentage of regulation**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to

1. construct the test circuit specified by the instructor or by the student's lab manual, in accordance with schematic diagram, or other information given the student by the instructor, or by the lab manual,
2. calculate all values of current and voltage obtainable from the values of the components in the circuit,
3. measure and record all values of current and voltage obtainable, or all values specified by the instructor, or by the student lab manual, and
4. calculate the percentage of voltage regulation of the zener diode regulator circuit.

3.20.3 COMPETENCY: **Calculate maximum load conditions**

ENABLING PERFORMANCE OBJECTIVE

1. Using informatino obtained from the steps above, the student will calculate the maximum load conditions for the zener diode regulator circuit.

2. Compare the measured readings with the expected readings.

3.20.4 COMPETENCY: **Measure effect of line voltage changes**

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to increase or decrease the voltage supplied to the zener regulator, and measure the amount of change in load voltage.

3.20.5 COMPETENCY: **Measure effect of load current changes**

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to increase or decrease the amount of load current supplied by the zener regulator, and measure the amount of change in load voltage.

TASKS
PERFORMANCE OBJECTIVES
COMPETENCIES
AND
ENABLING OBJECTIVES

3.21 TASK: Graph the Collector Characteristic Curves for a Bipolar Transistor

TERMINAL PERFORMANCE OBJECTIVE

1. **Measure and record the necessary voltages and currents in the transistor test circuit, by using several values of base current.**
2. **Graph the collector characteristic curves for the bipolar transistor.**
3. **Using the graph, determine the value of alpha and beta for specified values of V_{CE} and I_C.**

COMPETENCIES AND EPO'S

3.21.1 COMPETENCY: **Measure and record values of current and voltage for graph**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to:

1. Construct a circuit, in accordance with a schematic diagram, or other information provided by the instructor, or found in the student lab manual, or
2. the student may be provided with a test circuit, to be used with this lab objective,
3. calculate all necessary values before taking voltage, current or resistance readings on the circuit.
4. measure and record the necessary voltages and currents in the transistor test circuit, by using several values of base current, as specified in the lab manual, or by the instructor, and
5. graph the characteristic curves for the bipolar transistor, using at least 5 values of base current.

3.21.2 COMPETENCY: **Determine value of alpha from graph**

ENABLING PERFORMANCE OBJECTIVE

1. Using the information contained on the graph, determine the value of alpha for specified values of V_{CE}, I_C, and I_B.

3.21.3 COMPETENCY: **Determine value of beta from graph**

ENABLING PERFORMANCE OBJECTIVE

1. Using the information obtained from the graph, calculate the value of beta for the common emitter transistor hookup.

TASKS
PERFORMANCE OBJECTIVES
COMPETENCIES
AND
ENABLING OBJECTIVES

3.22 TASK: Measure Operating Conditions of a Bipolar Transistor Connected as Common Emitter, Common Base, and Common Collector Amplifier

TERMINAL PERFORMANCE OBJECTIVE

1. Measure and record the input and output waveforms for the bipolar transistor, hooked up in three different configurations: Common Emitter, Common Base, and Common Collector.
2. Compare the three configurations of amplifier in terms of voltage gain, current gain, power gain, and phase inversion.
3. Draw a DC load line of the transistor, and select the DC operating point, for class A bias.
4. Draw an AC load line, and determine the size of input signal, output signal, and AC beta.
5. Determine voltage gain and current gain of the stage, when connected in common emitter, base, or collector configurations.
6. Use transistor curve tracer to graph collector characteristic curves for common emitter circuit.
7. Measure voltage, or current in the circuit, for the common emitter, common base, and common collector circuits, with various frequencies of signal voltages applied to the input.
8. Graph frequency applied versus signal voltage output.
9. Using the information obtained from the graph, determine the frequency response of the amplifier stage under test, and evaluate the relationship of frequency response to type of hookup.

COMPETENCIES AND EPO'S

3.22.1 COMPETENCY: Draw DC load line

ENABLING PERFORMANCE OBJECTIVE

The student will be able to

1. use the graph from a previous competency to draw a DC load line,
2. determine the power supply voltage to be used with the transistor,
3. determine the maximum current possible through the transistor if the transistor were shorted from emitter to collector, or were conducting at $V_{CE(SAT)}$,
4. draw a DC load line, showing the two extremes of operation (cutoff and saturation) as the two ends of the load line.

3.22.2 COMPETENCY: **Determine operating point for class A bias**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to

1. determine a proper operating point on the characteristic curve that will allow class A operation of the amplifier, when connected as a common emitter amplifier,
2. using the graph, determine the correct value of I_C, I_B, and V_{CE}, for class A operation,
3. calculate the proper values of base resistor necessary to produce the proper base current for the common emitter amplifier, when operating with base bias (power supply bias), voltage divider bias, or collector feedback bias (self bias),
4. calculate the correct value of collector resistor necessary to produce the proper value of collector current, and collector to emitter voltage, for the common emitter amplifier, as determined from the operating point on the characteristic curve.

3.22.3 COMPETENCY: **Draw AC load line**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to

1. use the graph mentioned previously to determine the operation of the transistor under AC conditions,
2. from the information obtained from the graph, determine the amount of output voltage (AC), the amount of input current (AC), and amount of output current (AC), and
3. calculate AC beta from the preceding information.

3.22.4 COMPETENCY: **Determine current gain, voltage gain, power gain in amplifier circuits**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to

1. measure the change in output current for given change in input current, in common emitter, common collector, or common base amplifier circuits,
2. determine the current gain of the circuit,
3. measure the change in output voltage compared to change in input voltage,
4. determine the voltage gain of the circuit, and
5. calculate the power gain for each of the three configurations of transistor amplifier.

3.22.5 COMPETENCY: **Waveform analysis of amplifier circuits**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to

1. measure and record the input and output waveforms for the bipolar transistor, hooked up in three different configurations: Common Emitter, Common Base, and

Common Collector.

2. From the information obtained, the student will compare the three configurations of amplifier in terms of voltage gain, current gain, power gain, and phase inversion.

3.22.6 COMPETENCY: **Operate transistor curve tracer**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to

1. operate a transistor curve tracer to produce a family of characteristic curves for the common emitter amplifier,
2. draw a DC load line of the device under test, for a given set of conditions of collector to emitter voltage, collector current, and base current, by using information gathered from the curve tracer.

3.22.7 COMPETENCY: **Draw frequency response curve for each amplifier configuration**

ENABLING PERFORMANCE OBJECTIVE

The student will be able to

1. construct a circuit in accordance with a schematic diagram, or other information provided by the instructor, or found in the student lab manual, or
2. the student may be provided with a test circuit, to be used with this lab objective,
3. measure all necessary values before graphing voltage, or current readings in the circuit, for the common emitter, common base, and common collector circuits, with various frequencies of signal voltages applied to the input.
4. The student will transfer the information obtained to a graph of frequency applied versus signal voltage output.
5. Using the information obtained from the graph, the student will determine the frequency response of the amplifier stage under test, and evaluate the relationship of frequency response to type of hookup, when used as a common emitter, common base, or common collector type circuit.

TASKS
PERFORMANCE OBJECTIVES
COMPETENCIES
AND
ENABLING OBJECTIVES

3.23 TASK: Construct a Circuit to Provide Correct Bias Voltages for a Bipolar Transistor in the Class A, Class AB, Class B, and C Mode of Operation

TERMINAL PERFORMANCE OBJECTIVE

1. Construct a circuit to provide class A, B, AB, or C bias to a bipolar transistor connected as a common emitter amplifier.
2. Measure and record the input signal waveforms, and output signal waveforms, (as well as the DC voltages) on the base, emitter and collector of the transistor under test, for each of the classes of bias.
3. Determine the amplification factor, efficiency, power output, and amount of distortion for each class of bias.
4. Construct a circuit using the transistor as a switch, and measure the voltages on the base, emitter and collector, with and without an input signal to turn the switch on.

COMPETENCIES AND EPO'S

3.23.1 COMPETENCY: Define class A, B, AB, and C bias

ENABLING PERFORMANCE OBJECTIVE

The student will be able to
1. define class A bias in terms of output current flow compared to input current flow,
2. define class B bias in terms of output current flow compared to input current flow,
3. define class AB bias in terms of output current flow compared to input current flow,
4. define class C bias in terms of output current flow compared to input current flow, and
5. list reasons for the use of each of the classes of bias, and examples of types of circuits using each class of bias.

3.23.2 COMPETENCY: Measure circuit values for different classes of bias

ENABLING PERFORMANCE OBJECTIVE

The student will be able to
1. construct a circuit in accordance with a schematic diagram, or other information provided by the instructor, or found in the student lab manual, or
2. the student may be provided with a test circuit, to be

used with this lab objective,

3. calculate all necessary values before taking voltage, current or resistance readings on the circuit,
4. measure and record the input signal waveforms, and output signal waveforms, (as well as the DC voltages) on the base, emitter, and collector of the transistor under test, for each of the classes of bias.

3.23.3 COMPETENCY: **Determine efficiency, amplification factor, power output, and amount of distortion**

ENABLING PERFORMANCE OBJECTIVE

1. The student will determine the efficiency of the stage for each class of bias, as well as the amplification factor and the power output.
2. The student will be able to determine the amount of distortion present in the output, for each class of bias.

3.23.4 COMPETENCY: **Analyze transistor circuit used as a switch**

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to connect the transistor as a switch, given the correct schematic diagram of the circuit.
2. The student will be able to measure the base, collector, and emitter voltages, with the transistor turned off.
3. The student will be able to measure the base, collector, and emitter voltages, with an input signal to turn the transistor on.

TASKS
PERFORMANCE OBJECTIVES
COMPETENCIES
AND
ENABLING OBJECTIVES

3.24 TASK: Construct a Series Pass Transistor Voltage Regulator Circuit and Measure Circuit Values

TERMINAL PERFORMANCE OBJECTIVE

1. **Construct a series pass transistor voltage regulator circuit.**
2. **Measure all expected circuit values of voltage, current, resistance, dc voltage output, ripple frequency and amplitude.**
3. **Determine the effects of increasing or decreasing line voltage, or increasing or decreasing load current.**

COMPETENCIES AND EPO'S

3.24.1 COMPETENCY: **Construct and analyze transistor voltage regulator**

ENABLING PERFORMANCE OBJECTIVE

1. The student will construct a series pass transistor voltage regulator circuit from schematic diagrams given to him/her by the instructor, or other information provided by the lab manual.
2. The student will be able to calculate all expected circuit values of voltage, current, resistance, dc voltage output, ripple frequency and amplitude.

3.24.2 COMPETENCY: **Measure circuit values in transistor voltage regulator**

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to measure the circuit values with the VOM, and oscilloscope, and record the results.
2. From the results obtained, the student will be able to determine the dc voltage output, ripple frequency, and amplitude of ripple voltage, as well as the voltage drops, and current through each component.

3.24.3 COMPETENCY: **Determine effect of load current changes**

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to increase or decrease the load resistor for the series pass transistor voltage regulator and measure the results.

3.24.4 COMPETENCY: **Determine effect of line voltage changes**

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to increase or decrease the voltage supplied to the series pass transistor voltage regulator, and measure the results.

TASKS
PERFORMANCE OBJECTIVES
COMPETENCIES
AND
ENABLING OBJECTIVES

3.25 TASK: Construct JFET Amplifier Stage Biased for Maximum Undistorted Signal

TERMINAL PERFORMANCE OBJECTIVE

1. **Construct a JFET amplifier circuit.**
2. **Measure the voltage drops around the circuit and the current flow in the drain circuit, when the JFET amplifier is biased for maximum signal swing.**
3. **Calculate the transconductance and overall stage gain of the stage.**
4. **Analyze a FET transistor connected as a common source amplifier, using self bias, by measuring all voltage drops and signals in the stage.**

COMPETENCIES AND EPO'S

3.25.1 COMPETENCY: **Calculate and measure voltage and current in the JFET amplifier**

ENABLING PERFORMANCE OBJECTIVE

1. The student will construct a circuit, in accordance with a schematic diagram, or other information provided by the instructor, or found in the student lab manual, or
2. The student may be provided with a test circuit, to be used with this lab objective.
3. The student will calculate all necessary values before taking voltage or current readings on the circuit.
4. The student will measure the voltage drops around the circuit, and the current flow in the drain circuit, when the JFET amplifier is biased for maximum signal swing.

3.25.2 COMPETENCY: **Calculate transconductance of the JFET transistor**

ENABLING PERFORMANCE OBJECTIVE

1. The student will use the information obtained from the previous competency to calculate the transconductance of the JFET under test.

3.25.3 COMPETENCY: **Calculate amount of amplification of the stage**

ENABLING PERFORMANCE OBJECTIVE

1. The student will use the information obtained from the first competency (3.25.1) to calculate the overall

stage gain of the stage.

3.25.4 COMPETENCY: **Troubleshoot JFET amplifier stage**

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to measure any circuit values necessary, to determine whether stage is in need of repair.
2. The student will determine cause of any malfunction, and repair it, either by replacing a defective part, adjusting a component to the correct value, or changing the design parameters as necessary, to cause the JFET amplifier to operate correctly.

3.25.5 COMPETENCY: **Analyze circuit conditions with FET transistor connected as a common source amplifier**

ENABLING PERFORMANCE OBJECTIVE

1. The student will construct a circuit, in accordance with a schematic diagram, or other information provided by the instructor, or found in the student lab manual, or
2. The student may be provided with a test circuit, to be used with this lab objective.
3. The student will calculate all necessary values before taking voltage or current readings on the circuit.
4. The student will measure the voltage drops around the circuit, and the current flow in the drain circuit, when the FET amplifier is connected as a common source amplifier, using self bias.

TASKS
PERFORMANCE OBJECTIVES
COMPETENCIES
AND
ENABLING OBJECTIVES

3.26 TASK: Construct a Drain Characteristic Curve for a MOSFET Transistor

TERMINAL PERFORMANCE OBJECTIVE

1. **Connect the MOSFET transistor to a test circuit, measure and record the drain current and voltage from drain to source for several values of gate voltage.**
2. **Transfer the data obtained to graph paper and construct a drain characteristic curve.**
3. **Observe necessary cautions in handling due to static electricity.**

COMPETENCIES AND EPO'S

3.26.1 COMPETENCY: **Measure and record values of drain current, and drain to source voltage**

ENABLING PERFORMANCE OBJECTIVE

1. The student will construct a circuit, in accordance with a schematic diagram, or other information provided by the instructor, or found in the student lab manual, or
2. The student may be provided with a test circuit, to be used with this lab objective.
3. The student will calculate all necessary values before taking voltage, current or resistance readings on the circuit.
4. The student will connect the MOSFET transistor to the test circuit, measure and record the drain current, and voltage from drain to source for several values of gate voltage.
   NOTE; MOSFET DEVICES ARE EXTREMELY SENSITIVE TO ELECTROSTATIC DISCHARGE. FOLLOW PRECAUTIONS TO AVOID DAMAGING DEVICE.

3.26.2 COMPETENCY: **Construct drain characteristics curve**

ENABLING PERFORMANCE OBJECTIVE

1. The student will transfer the data obtained to graph paper and construct a drain characteristic curve.

3.26.3 COMPETENCY: **Demonstrate safe handling techniques for MOSFETS**

ENABLING PERFORMANCE OBJECTIVE

1. The student will demonstrate the proper handling procedures for the MOSFET devices used in the lab, by safely

removing MOSFET devices from protective wrapper, installing them into the circuit boards, and using correct antistatic procedures and equipment, during servicing or measurement.

TASKS
PERFORMANCE OBJECTIVES
COMPETENCIES
AND
ENABLING OBJECTIVES

3.27 TASK: Measure the Effects of Degenerative Feedback in an Amplifier Circuit

TERMINAL PERFORMANCE OBJECTIVE

1. **Construct a circuit, or use a test circuit of a two stage bipolar transistor amplifier with DC coupling.**
2. **Measure all voltage drops across all components in the circuit, and measure, directly or indirectly, the current flow through each component. Using the oscilloscope, observe the waveforms at input and output, and record them.**
3. **Determine the gain of the stage, and the frequency response, with degenerative feedback.**
4. **Disconnect any resistors used for feedback, and perform measurements again, to determine the effects that degenerative feedback had on the circuitry.**

COMPETENCIES AND EPO'S

3.27.1 COMPETENCY: **Calculate and measure circuit values**

ENABLING PERFORMANCE OBJECTIVE

1. The student will construct a circuit, in accordance with a schematic diagram, or other information provided by the instructor, or found in the student lab manual, or
2. The student may be provided with a test circuit, of a two stage bipolar transistor amplifier, with DC coupling, to be used with this lab objective.
3. The student will calculate all necessary values before taking voltage, current or resistance readings on the circuit.
4. The student will measure all voltage drops across all components in the circuit, and measure, directly, or indirectly, the current flow through each component. Using the oscilloscope, the student will observe the waveforms at input and output, and record them.

3.27.2 COMPETENCY: **Determine amplifier gain, and frequency response with feedback**

ENABLING PERFORMANCE OBJECTIVE

1. Using the information gathered, the student will determine the gain of the amplifier, and the frequency response with degenerative feedback.

3.27.3 COMPETENCY: **Determine gain, frequency response without feedback**

ENABLING PERFORMANCE OBJECTIVE

1. The student will disconnect any resistors used for feedback, and perform measurements again, to determine the effects that degenerative feedback had on the circuitry.

3.27.4 COMPETENCY: **Compare results with and without feedback**

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to compare the frequency response of the amplifier with degenerative feedback, to the amplifier without degenerative feedback, to determine the difference, if any.
2. The student will be able to compare the gain of the amplifier with feedback to the amp without feedback, to determine the difference, if any.
3. The student will be able to list two advantages of the amp with degenerative feedback, in terms of frequency response and stability.
4. The student will be able to list one disadvantage of degenerative feedback in terms of gain.

TASKS
PERFORMANCE OBJECTIVES
COMPETENCIES
AND
ENABLING OBJECTIVES

4.3 TASK: Calculate Power Dissipation of Diodes

TERMINAL PERFORMANCE OBJECTIVE

1. **Calculate the power dissipation of a rectifier diode.**
2. **Calculate the power dissipation of an LED diode.**
3. **Calculate the power dissipation of a zener diode.**

COMPETENCIES AND EPO'S

4.3.1 COMPETENCY: **Calculate power dissipation of rectifier**

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to calculate the power dissipation of a rectifier diode, by using information obtained from the graph of current and voltage for the diode.

4.3.2 COMPETENCY: **Calculate power dissipation of LED diode**

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to calculate the power dissipation of a LED diode, when given the necessary information concerning current through the diode, and voltage across the diode, or when given the characteristic curve of the LED diode.

4.3.3 COMPETENCY: **Calculate power dissipation of zener diode**

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to calculate the power dissipation of a zener diode, when given the necessary information to determine the current through the diode, voltage across the diode, and/or characteristic curve of the zener diode.

TASKS
PERFORMANCE OBJECTIVES
COMPETENCIES
AND
ENABLING OBJECTIVES

4.4 TASK: Identify Types of Diodes

TERMINAL PERFORMANCE OBJECTIVE

1. **List the characteristics and schematic symbol for the zener diode, light emitting diode, photodiode, varactor diode, and silicon controlled rectifier diode.**

COMPETENCIES AND EPO'S

4.4.1 COMPETENCY: **List symbol and characteristics of zener diode**

ENABLING PERFORMANCE OBJECTIVE

1. The student will list the characteristics and schematic symbol for the zener diode; or may be required to select the correct response from a list of possible choices, concerning the different types of diodes.

4.4.2 COMPETENCY: **List symbol and characteristics of LED diode**

ENABLING PERFORMANCE OBJECTIVE

1. The student will list the characteristics and schematic symbol for the light emitting diode; or may be required to select the correct response from a list of possible choices, concerning the different types of diodes.

4.4.3 COMPETENCY: **List symbol and characteristics of photodiode**

ENABLING PERFORMANCE OBJECTIVE

1. The student will list the characteristics and schematic symbol for the photodiode; or may be required to select the correct response from a list of possible choices, concerning the different types of diodes.

4.4.4 COMPETENCY: **List symbol and characteristics of varactor diode**

ENABLING PERFORMANCE OBJECTIVE

1. The student will list the characteristics and schematic symbol for the varactor diode; or may be required to select the correct response from a list of possible choices, concerning the different types of diodes.

4.4.5 COMPETENCY: **List symbol and characteristics of SCR**

ENABLING PERFORMANCE OBJECTIVE

1. The student will list the characteristics and schematic symbol for the silicon controlled rectifier diode, or may be required to select the correct response from a list of possible choices concerning the different types of diodes.

TASKS
PERFORMANCE OBJECTIVES
COMPETENCIES
AND
ENABLING OBJECTIVES

4.5 TASK: Schematic Drawing of Important Electronic Circuits

TERMINAL PERFORMANCE OBJECTIVE

1. Draw the schematic diagram of the following electronic circuits:
   a. Half wave rectifier, resistive load.
   b. Full wave rectifier, center tapped, resistive load.
   c. Full wave bridge rectifier, resistive load.
   d. Full wave rectifier, split supply (+ and -).
   e. Voltage doubler, limiter, clipper, clamper, and peak to peak detector circuit.
   f. Common Emitter amplifier with collector feedback biasing.
   g. Common Emitter amplifier, with voltage divider biasing.
   h. Common Emitter amplifier, with base biasing. (power supply biasing)
   i. Common Emitter amplifier, with bias obtained by using dual power supplies, one + and one - supply.
   j. Single Stage Inverting Amplifier, with voltage divider bias, operated Class A.
   k. Two Stage Cascaded Amplifier, DC Coupled, Common Emitter types, with both stages NPN or PNP transistors.
   l. Class B operated Push-Pull amplifier, with both transistors the same type (NPN or PNP), transformer coupled inputs.
   m. Common Base amplifier using biasing voltage supplied to the emitter.
   n. Self biasing, Current Source biasing, Zero biasing, and Drain Feedback biasing circuits, for the FET transistor circuit.
   o. Darlington pair amplifier, showing external C, B, and E connections to the amplifier.

COMPETENCIES AND EPO'S

4.5.1 COMPETENCY: Schematic diagram half wave rectifier

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to draw the schematic diagram, from memory, of the half wave rectifier, resistive load. Note: The student will not be required to supply component values, but must supply component designations; such as R1, Q3, etc.

4.5.2 COMPETENCY: **Schematic diagram full wave rectifier, center tapped**

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to draw the schematic diagram, from memory, of the full wave rectifier, center tapped, resistive load.
   Note: The student will not be required to supply component values, but must supply component designations; such as R1, Q3, etc.

4.5.3 COMPETENCY: **Schematic diagram full wave rectifier**

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to draw the schematic diagram, from memory, of the full wave bridge rectifier, resistive load.
   Note: The student will not be required to supply component values, but must supply component designations; such as R1, Q3, etc.

4.5.4 COMPETENCY: **Schematic diagram full wave rectifier, split supply**

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to draw the schematic diagram, from memory, of the full wave rectifier, split supply (+ and -).
   Note: The student will not be required to supply component values, but must supply component designations; such as R1, Q3, etc.

4.5.5 COMPETENCY: **Schematic diagram voltage doubler**

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to draw the schematic diagram, from memory, of the voltage doubler.
   Note: The student will not be required to supply component values, but must supply component designations; such as R1, Q3, etc.

4.5.6 COMPETENCY: **Schematic diagram of limiter circuit**

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to draw the schematic diagram, from memory, of the limiter.
   Note: The student will not be required to supply component values, but must supply component designations; such as R1, Q3, etc.

4.5.7 COMPETENCY: **Schematic diagram of clipper circuit**

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to draw the schematic diagram, from memory, of the clipper.
   Note: The student will not be required to supply component values, but must supply component designations; such as R1, Q3, etc.

4.5.8 COMPETENCY: **Schematic diagram of clamper circuit**

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to draw the schematic diagram, from memory, of the clamper.
   Note: The student will not be required to supply component values, but must supply component designations; such as R1, Q3, etc.

4.5.9 COMPETENCY: **Schematic diagram of peak-to-peak detector**

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to draw the schematic diagram, from memory, of the peak to peak detector circuit.
   Note: The student will not be required to supply component values, but must supply component designations; such as R1, Q3, etc.

4.5.10 COMPETENCY: **Schematic diagram common emitter amp with collector feedback biasing**

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to draw the schematic diagram, from memory, of the common emitter amplifier, with collector feedback biasing.
   Note: The student will not be required to supply component values, but must supply component designations; such as R1, Q3, etc.

4.5.11 COMPETENCY: **Schematic diagram common emitter amp with voltage divider biasing**

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to draw the schematic diagram, from memory, of the common emitter amplifier, with voltage divider biasing.
   Note: The student will not be required to supply component values, but must supply component designations; such as R1, Q3, etc.

4.5.12 COMPETENCY: **Schematic diagram common emitter amp with base bias**

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to draw the schematic diagram, from memory, of the common emitter amplifier, with base biasing, (power supply biasing)
   Note: The student will not be required to supply component values, but must supply component designations; such as R1, Q3, etc.

4.5.13 COMPETENCY: **Schematic diagram split supply common emitter amp**

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to draw the schematic diagram, from memory, of the common emitter amplifier, with bias obtained by using dual power supplies, one + and one - supply.
   Note: The student will not be required to supply component values, but must supply component designations; such as R1, Q3, etc.

4.5.14 COMPETENCY: **Schematic diagram inverter with voltage divider bias**

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to draw the schematic diagram, from memory, of the single stage inverting amplifier, with voltage divider bias, operated class A.
   Note: The student will not be required to supply component values, but must supply component designations; such as R1, Q3, etc.

4.5.15 COMPETENCY: **Schematic diagram 2 stage cascaded common emitter DC-coupled amps**

ENABLING PERFORMANCE OBJECTIVES

1. The student will be able to draw the schematic diagram, from memory, of the two stage cascaded amplifier, DC coupled, common emitter types, with both stages NPN or PNP transistors.
   Note: The student will not be required to supply component values, but must supply component designations; such as R1, Q3, etc.

4.5.16 COMPETENCY: **Schematic diagram push-pull transformer coupled inputs**

ENABLING PERFORMANCE OBJECTIVES

1. The student will be able to draw the schematic diagram, from memory, of the Class B operated Push-Pull amplifier, with both transistors the same type (NPN or PNP), with transformer coupled inputs.
   Note: The student will not be required to supply component values, but must supply component designations; such as R1, Q3, etc.

4.5.17 COMPETENCY: **Schematic diagram common base amp with emitter bias**

ENABLING PERFORMANCE OBJECTIVES

1. The student will be able to draw the schematic diagram, from memory, of the common base amplifier, using biasing voltage supplied to the emitter.
   Note: The student will not be required to supply component values, but must supply component designations; such as R1, Q3, etc.

4.5.18 COMPETENCY: **Schematic diagram self bias, current source bias, zero bias, and drain feedback bias for FET's**

ENABLING PERFORMANCE OBJECTIVES

1. The student will be able to draw the schematic diagram, from memory, of self biasing, current source biasing, zero biasing, and drain feedback biasing circuits, for the FET transistor circuit.
   Note: The student will not be required to supply component values, but must supply component designations; such as R1, Q3, etc.

4.5.19 COMPETENCY: **Schematic diagram Darlington amp with external connections**

ENABLING PERFORMANCE OBJECTIVES

1. The student will be able to draw the schematic diagram, from memory, of the Darlington pair amplifier, showing external C, B, and E connections to the amplifier.
   Note: The student will not be required to supply component values, but must supply component designations; such as R1, Q3, etc.

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TERMINAL PERFORMANCE OBJECTIVES
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AND
ENABLING OBJECTIVES

ELECTRON CONTROL DEVICES
THEORY

IDAHO STANDARDIZED ELECTRONICS
CURRICULUM

PREPARED 13 April, 1985
REVISED 9 December, 1986
BY Electronics Curriculum Committee
Area Vocational Technical Schools
State of Idaho

State of Idaho - Electronics Technology Standardized Vocational Program

PERFORMANCE STANDARDS

The following is a list of measurable performance objectives for the Electron Control Devices Theory portion of the standardized Electronics Technology Program for the State of Idaho Vocational Electronics Curriculum.

This listing is intended to be a simple, easy to read format of the performance standards for this portion of the course. The student, as well as the instructor, can see at a glance the tasks, terminal performance objectives, competencies, and enabling performance objectives that are necessary for completion of this section.

The following list of Conditions and Criteria are intended to be the Conditions and Criteria to be used with each of the Performance Objectives listed later in this document. Where the exact conditions cannot be met, the instructor will be responsible to insure that the purpose of the objective is accomplished, to guarantee the level of learning necessary for the success of the student.

CONDITIONS:

1. The student may use a calculator, except where specifically prohibited in the objective statement. All simple operations, however, should be performed without the use of a calculator.
2. All answers to mathematical calculations must be accurate to tolerances, determined by the instructor.
3. Calculations involving numbers extracted from a graph, must be accurate to tolerances determined by the instructor.
4. The student will be required to list units of measurement, with the numerical answer, in all cases in which the unit of measurement is an integral part of the answer, such as 5 volts, 1 ampere, 4.7 kilohms.
5. The instructor will insure that the student is exposed to the necessary activities as many times as is needed to insure that the student not only can perform the objective once, but can retain the knowledge to use it at a later time, as well.

CRITERIA:

1. All answers must be accurate to within tolerances specified by the instructor, for mathematical solutions, or graphical solutions.
2. Accomplishment of the performance objective may be tested on more than one occasion, through the use of questions on subsequent exams, that test the performance objective. (Review Questions)
3. Retention of the knowledge of the information covered by the objective may be tested at a later time, by exam items on a final exam, given at the end of the session.

TASKS
PERFORMANCE OBJECTIVES
COMPETENCIES
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4.1 TASK: Describe the Structure and Characteristics of the PN Junction Diode

TERMINAL PERFORMANCE OBJECTIVE

1. Describe what a crystal lattice is and describe covalent bonding, tetravalency, trivalency, and pentavalency.
2. Describe the effects of doping on semiconductor materials to produce N and P type semiconductor crystals.
3. Describe the structure and characteristics of the PN junction diode.
4. Define the terms depletion region, barrier potential and forward voltage drop.
5. Describe the theory of operation of the diode under avalanche breakdown, and zener breakdown conditions.
6. Calculate the operating point of a diode, from information obtained from the graph of current versus voltage.
7. Calculate the AC resistance of the diode from the load line drawn on the graph of current versus voltage.

COMPETENCIES AND EPO'S

4.1.1 COMPETENCY: **Define crystal lattice**

ENABLING PERFORMANCE OBJECTIVE
1. The student will describe what a crystal lattice is.

4.1.2 COMPETENCY: **Define covalent bonding**

ENABLING PERFORMANCE OBJECTIVE
1. The student will describe the term covalent bonding.

4.1.3 COMPETENCY: **Define tetravalency**

ENABLING PERFORMANCE OBJECTIVE
1. The student will describe the term tetravalency.

4.1.4 COMPETENCY: **Define trivalency**

ENABLING PERFORMANCE OBJECTIVE
1. The student will describe the term trivalency.

4.1.5 COMPETENCY: **Define pentavalency**

ENABLING PERFORMANCE OBJECTIVE
1. The student will describe the term pentavalency.

4.1.6 COMPETENCY: **Describe effects of doping of semiconductors**

ENABLING PERFORMANCE OBJECTIVE

1. The student will describe the effects of doping on semiconductor materials to produce N and P type semiconductor crystals, or may be required to select the correct descriptions from a list of possible choices, concerning doping of semiconductor materials.

4.1.7 COMPETENCY: **Describe structure & characteristics of diode**

ENABLING PERFORMANCE OBJECTIVE

1. The student will describe the structure and characteristics of the PN junction diode.

4.1.8 COMPETENCY: **Define depletion region**

ENABLING PERFORMANCE OBJECTIVE

1. The student will define the term depletion region.

4.1.9 COMPETENCY: **Define barrier potential**

ENABLING PERFORMANCE OBJECTIVE

1. The student will define the term barrier potential.

4.1.10 COMPETENCY: **Define forward voltage drop**

ENABLING PERFORMANCE OBJECTIVE

1. The student will define the term forward voltage drop, or may be required to select the correct responses, from a list of possible responses, concerning operating conditions of a diode.

4.1.11 COMPETENCY: **Describe breakdown conditions of a diode**

ENABLING PERFORMANCE OBJECTIVE

1. The student will describe the theory of operation of the diode under avalanche breakdown and zener breakdown conditions; or may be required to select the correct responses from a list of possible responses, concerning breakdown conditions of a diode.

4.1.12 COMPETENCY: **Determine operating point from load line**

ENABLING PERFORMANCE OBJECTIVE

1. The student will calculate the operating point of a diode and calculate the AC resistance of the diode, from information obtained from the graph of current versus voltage.

TASKS
PERFORMANCE OBJECTIVES
COMPETENCIES
AND
ENABLING OBJECTIVES

4.2 TASK: Compare Ideal Diode to the Practical Diode

TERMINAL PERFORMANCE OBJECTIVE

1. **Make a comparison of the ideal diode and an actual diode in terms of leakage current, barrier voltage and nonlinearity of the graph of current and voltage.**

COMPETENCIES AND EPO'S

4.2.1 COMPETENCY: **Compare leakage current of ideal & actual diode**

ENABLING PERFORMANCE OBJECTIVE

1. The student will make a comparison of the ideal diode and an actual diode in terms of leakage current, by using the characteristic curve for the diode as a source of information

4.2.2 COMPETENCY: **Compare barrier potential of ideal & actual diodes**

ENABLING PERFORMANCE OBJECTIVE

1. The student will make a comparison of the ideal diode and an actual diode in terms of barrier voltage, by using the characteristic curve for the diode as a source of information.

4.2.3 COMPETENCY: **Compare linearity of characteristic curve of current and voltage**

ENABLING PERFORMANCE OBJECTIVE

1. The student will make a comparison of the ideal diode and an actual diode in terms of linearity of the graph of current and voltage, by using the characteristic curve for the diode as a source of information.

PERFORMANCE OBJECTIVES PERTAINING TO SHOP SAFETY

THE FOLLOWING OBJECTIVES, RELATING TO SHOP SAFETY, ARE CONSIDERED MORE IMPORTANT THAN ANY OTHER OBJECTIVES IN THE LAB. THE SAFETY RULES RELATED TO ELECTRONICS ARE NOT TO BE TAKEN LIGHTLY, SINCE ONE LAPSE MAY RESULT IN DEATH OR PERMANENT INJURY. THEREFORE, NO INFRACTION WILL BE ALLOWED. STUDENTS WHO INSIST ON IGNORING, OR DELIBERATELY VIOLATING SAFETY RULES, MAY BE DISMISSED FROM THE PROGRAM WITHOUT RECOURSE.

A safety test will be given to each student, at the beginning of the session, before the student may work on electrical or electronic equipment. The minimum acceptable score on the safety test is 100%. The safety test will be kept on file in the student's records for the duration of time the student is enrolled in the program. The student will sign the test paper, and will be held responsible for the knowledge tested by the safety test. The instructor's responsibility shall be to enforce the safety rules and procedures in the lab, insure that each student has been taught safe handling procedures for equipment used in the lab, and report any safety problems encountered to the proper authorities. The student will be given a copy of the safety test for his/her records.

CRITERIA:

1. If a safety violation is observed, or any unsafe condition in regards to the equipment is discovered, the student must report this to the instructor.
2. Terminal performance will not be evaluated through the use of an exam, but will instead be evaluated on a daily basis, as the student works in the lab, on lab projects, as part of the overall evaluation of the lab project.
3. Retention of the knowledge of the information covered by this objective will be tested continuously, to insure compliance with the safety rules necessary for safe work in the lab.
4. No numerical or letter grade will be assigned to these objectives, but compliance with the conditions and criteria are mandatory to remain in the program.

TASKS
PERFORMANCE OBJECTIVES
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3.28 TASK: Observe Safety Rules and Precautions in Lab

TERMINAL PERFORMANCE OBJECTIVE

1. Define terms related to safety and describe general safety rules and procedures.
2. Identify safety rules and procedures associated with electrical safety and work safely with electrical equipment.
3. Identify correct procedures for treatment and prevention of electrical shock.
4. Identify safety rules and procedures associated with fire safety and work to eliminate fire hazards.
5. Identify safety rules and procedures associated with hand tool safety and work safely with hand tools.
6. Identify safety rules and procedures associated with soldering and work safely with soldering and desoldering equipment.
7. Demonstrate proper handling procedures for those components that are sensitive to electro-static discharge, and prevent damage when handling in the lab.

COMPETENCIES

3.28.1 COMPETENCY: **Define the Term Safety**

ENABLING PERFORMANCE OBJECTIVE

1. The student will define the meaning of the word safety, or
2. from a list of possible definitions of the word safety, select the correct choice.

3.28.2 COMPETENCY: **Define Terms Associated with Electrical Safety**

ENABLING PERFORMANCE OBJECTIVE

1. The student will define the terms associated with electrical safety, or
2. select the correct definitions from a list of possible choices pertaining to electrical safety.

3.28.3 COMPETENCY: **Identify the Hazards of Electrical Shock**

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to identify facts concerning the hazards of electrical shock, by selecting the correct responses from a list of possible hazards of electrical shock.

3.28.4 COMPETENCY: **Identify the Correct Procedure for Treatment of Electrical Shock**

ENABLING PERFORMANCE OBJECTIVE

1. The student will identify the correct procedure for treating a victim of electrical shock, by selecting the correct choices from a list of possible choices pertaining to the treatment of shock victims.

3.28.5 COMPETENCY: **Identify Types of Fire**

ENABLING PERFORMANCE OBJECTIVE

1. The student will identify the different classes of fires, by selecting the correct responses from a list of possible choices pertaining to classes of fire.
2. The student will be able to point out the location of the fire alarms in the vicinity of the lab area.

3.28.6 COMPETENCY: **Identify Types of Fire Extinguishers**

ENABLING PERFORMANCE OBJECTIVE

1. The student will match the definition of classes of fire with the type of fire extinguisher used, by selecting the correct responses from a list of possible choices concerning fire extinguishers and classes of fires.
2. The student will be aware of the location and the type of all fire extinguishers in the area of the lab.

3.28.7 COMPETENCY: **Describe General Safety Rules**

ENABLING PERFORMANCE OBJECTIVE

1. The student will describe the general safety rules observed in the lab, or
2. select from a list of possible safety rules the ones that are correct for the electronics lab.

3.28.8 COMPETENCY: **Identify Safety Rules for Hand Tools**

ENABLING PERFORMANCE OBJECTIVE

1. The student will list all safety rules applicable to the hand tools contained in the Standard Tool Box, described at the beginning of the performance objectives for the electronics lab portion of the course, or
2. select the correct choices from a list of possible choices pertaining to hand tool safety.

3.28.9 COMPETENCY: **Identify Power Tool Safety Rules**

ENABLING PERFORMANCE OBJECTIVE

1. The student will list the safety rules necessary for operation of the common electrical equipment used in the lab, or
2. select the correct responses from a list of possible choices pertaining to electrical power equipment safety.

3.28.10 COMPETENCY: **Identify the Safety Rules Pertaining to Electrical Cords**

ENABLING PERFORMANCE OBJECTIVE

1. The student will list all safety rules relevant to the safe use of electrical cords, or
2. be able to select the correct safety rules from a list of possible choices pertaining to electrical cord safety.

3.28.11 COMPETENCY: **Demonstrate General Safety by Working Safely**

ENABLING PERFORMANCE OBJECTIVE

1. The student will demonstrate a knowledge of general safety rules by working safely in the lab, to prevent injury to himself/herself or others while working in the lab.
2. The student will also demonstrate the correct attitude toward general safety by reporting any safety related problems to the instructor.

3.28.12 COMPETENCY: **Demonstrate Hand Tool Safety by Working Safely with Hand Tools**

ENABLING PERFORMANCE OBJECTIVE

1. The student will demonstrate a knowledge of safety with hand tools by working safely in the lab with hand tools, without injury, mishap, or infraction of safety rules.
2. The student will seek training in the use of any hand tools not used before from the instructor and the lab manual, before using.
3. The student will be responsible for maintaining his/her hand tools in safe condition, and to use them in a safe manner.

3.28.13 COMPETENCY: **Demonstrate Electrical Safety by Working Safely With Electrical Equipment and Power Tools**

ENABLING PERFORMANCE OBJECTIVE

1. The student will demonstrate a knowledge of electrical safety by working in the lab, with electrical equipment, including electrical power tools and test equipment, without injury, mishap, or infraction of the electrical safety rules.
2. The student will seek training, from the instructor, and the manual of operation, for any equipment he/she has not previously used. The student will be allowed to operate that piece of equipment, only after the instructor has tested student's knowledge of the safety rules for that equipment.
3. The student will be responsible for checking each piece of equipment he/she operates, for frayed wiring, missing ground connections, arcing, brittle or cracked insulation on power cords, or other obvious safety problems observed while operating the equipment, and to report these conditions to the instructor immediately.

3.28.14 COMPETENCY: **Demonstrate Proper Handling Procedures for CRT Tubes**

ENABLING PERFORMANCE OBJECTIVE

1. The student will demonstrate a knowledge of safety as related to the handling of Cathode Ray Tubes, by safely handling CRT tubes in the lab.
2. The student will be able to demonstrate knowledge of CRT safety, by either safely evacuating a defective CRT, or by demonstrating the correct procedure to the instructor.

3.28.15 COMPETENCY: **Demonstrate Safety Precautions for Capacitors**

ENABLING PERFORMANCE OBJECTIVE

1. The student will demonstrate the correct procedure for working on circuitry containing capacitors that may be charged up to some high voltage.
2. The student will demonstrate the correct procedure for working on capacitive circuitry, by safely discharging all capacitors before inserting hands into the circuitry to affect repairs, or perform any other test with the equipment turned off.
3. The student will also insure that only capacitors with a sufficiently high rating be used as replacement capacitors, and that all polarized capacitors will be inserted with the proper polarity.

3.28.16 COMPETENCY: **Demonstrate Safe Soldering Techniques**

ENABLING PERFORMANCE OBJECTIVE

1. The student will demonstrate the safety precautions to be observed while soldering, by following the safety rules while soldering in the lab.
2. The student will solder only with proper ventilation, and while wearing proper protective clothing and equipment, as required by the instructor.

3.28.17 COMPETENCY: **Demonstrate Safe "Anti-Static" Handling Techniques**

ENABLING PERFORMANCE OBJECTIVE

1. The student will demonstrate proper handling techniques to be used when danger to the circuitry exists from electrostatic discharge.
2. The student will use the necessary equipment to reduce the danger of electrostatic discharge, while working on circuitry in the lab.

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Common collector
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PERFORMANCE OBJECTIVES
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4.6 TASK: Calculate Current Limiting Resistor Values

TERMINAL PERFORMANCE OBJECTIVE

1. **Calculate the value of limiting resistor necessary for proper operation of an LED circuit.**
2. **Calculate the value of limiting resistor necessary for proper operation of a zener diode regulator circuit.**
3. **Calculate the value of limiting resistor necessary for proper operation of a rectifier circuit.**

COMPETENCIES AND EPO'S

4.6.1 COMPETENCY: **Determine the current rating of rectifier diode**

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to determine, from the characteristic curve, or from a data sheet, the safe current allowable through the rectifier diode in question.

4.6.2 COMPETENCY: **Calculate resistor to limit current through rectifier diode**

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to calculate the value of limiting resistor necessary for proper operation of a rectifier circuit, when given information regarding operating voltage of the circuit and the current rating of the diode.
2. The student will be able to determine the value of limiting resistor necessary when given information concerning wattage rating and operating voltage of the circuit, for a rectifier diode.
3. The student will be able to calculate the value of limiting resistor necessary for proper operation of a rectifier circuit from the characteristic curve of voltage and current.

4.6.3 COMPETENCY: **Determine current rating of zener diode**

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to determine the current rating of a zener diode from the characteristic curve of the diode.
2. The student will be able to determine the current rating of the zener diode from a data sheet for the diode.

3. The student will be able to determine the current rating of a zener diode from the wattage rating and the voltage used in the circuit.

4.6.4 COMPETENCY: **Calculate the limiting resistor size for zener diode**

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to calculate the value of limiting resistor necessary for proper operatin of a zener diode regulator circuit from the characteristic curve of voltage and current.
2. The student will be able to calculate the value of limiting resistor necessary for proper operation of a zener diode regulator circuit when given sufficient information concerning the voltage in the circuit, and the current rating of the zener diode.
3. The student will be able to calculate the value of limiting resistor necessary for proper operation of a zener diode regulator circuit when given sufficient information concerning the wattage rating of the zener diode, and the voltage in the circuit.

4.6.5 COMPETENCY: **Calculate limiting resistor for LED circuit**

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to calculate the value of limiting resistor necessary for proper operation of an LED circuit when given sufficient information regarding the wattage rating, current rating and/or voltage used in the circuit.

TASKS
PERFORMANCE OBJECTIVES
COMPETENCIES
AND
ENABLING OBJECTIVES

4.7 TASK: Draw the Output Waveform; List Advantages and Disadvantages of Types of Rectifier Circuits

TERMINAL PERFORMANCE OBJECTIVE

1. **Draw the output waveform for the half wave rectifier circuit and the full wave rectifier circuits.**
2. **Discuss advantages and disadvantages of each of the types of rectifier circuits.**

COMPETENCIES AND EPO'S

4.7.1 COMPETENCY: **Waveform for half wave resistive load circuit**

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to draw the output waveforms of the half wave rectifier, with resistive load.

4.7.2 COMPETENCY: **Waveforms for full wave center tapped power supply**

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to draw the output waveforms of the full wave rectifier, center tapped, with resistive load.

4.7.3 COMPETENCY: **Waveforms for full wave bridge rectifier power supply**

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to draw the output waveforms of the full wave bridge rectifier with resistive load.

4.7.4 COMPETENCY: **Waveforms for full wave split supply**

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to draw the output waveforms of the full wave split supply (+ and -) rectifier.

4.7.5 COMPETENCY: **Waveforms for voltage doubler**

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to draw the output waveforms of the voltage doubler.

4.7.6 COMPETENCY: **List advantages and disadvantages of each circuit**

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to list at least one advantage of each of the five power supply circuits listed above.
2. The student will be able to list at least one disadvantage of each of the circuits.

TASKS
PERFORMANCE OBJECTIVES
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AND
ENABLING OBJECTIVES

4.8 TASK: Analyze Capacitive Power Supply Filtering Networks

TERMINAL PERFORMANCE OBJECTIVE

1. **Describe the theory of operation of capacitive power supply filtering networks.**
2. **Determine the approximate average DC output voltage and peak voltage, and calculate the percentage of ripple voltage; as well as the ripple frequency and percent regulation, for various load requirements.**
3. **Calculate the amount of surge current that will occur in a capacitive power supply filter network and determine the correct size of surge resistor necessary to protect the rectifier diode.**

COMPETENCIES AND EPO'S

4.8.1 COMPETENCY: **Describe operation of capacitive filter networks**

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to describe the theory of operation of capacitive power supply filtering networks, or may be required to select the correct responses, from a list of possible choices, concerning capacitive filtering, for both half wave rectifier circuits, and full wave rectifier circuits.

4.8.2 COMPETENCY: **Calculate DC output voltage**

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to determine the approximate average DC output voltage for various load requirements.

4.8.3 COMPETENCY: **Calculate peak voltage**

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to determine the approximate peak voltage, for half wave and full wave rectifiers with capacitive power supply filter networks.

4.8.4 COMPETENCY: **Calculate percent ripple voltage**

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to calculate the percentage of ripple voltage for various load requirements, for half wave and full wave rectifier circuits.

4.8.5 COMPETENCY: **Calculate ripple frequency**

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to calculate the ripple frequency, for both half wave rectifier circuits, and full wave rectifier circuits.

4.8.6 COMPETENCY: **Calculate percent regulation**

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to calculate the percent regulation for various load requirements.

4.8.7 COMPETENCY: **Calculate surge current and surge resistor**

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to calculate the amount of surge current that will occur in a capacitive power supply filter network, and determine the correct size of surge resistor necessary to protect the rectifier diode.

TASKS
PERFORMANCE OBJECTIVES
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AND
ENABLING OBJECTIVES

4.9 TASK: Calculate Circuit Values for Voltage Multiplier Circuits, Clippers, Clampers, Peak Detectors, and Limiters

TERMINAL PERFORMANCE OBJECTIVE

1. **Calculate voltage across each component, and the current through each component, in a clipper, clamper, peak detector, limiter, and voltage multiplier circuit.**
2. **Describe the theory of operation of a clipper circuit, clamper circuit, peak detector, limiter circuit, and voltage multiplier circuit.**

COMPETENCIES AND EPO'S

4.9.1 COMPETENCIES: **Analyze operation of clipper circuit**

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to calculate voltage across each component in a clipper circuit, and the current through each component, when given sufficient information from which to extract the necessary data.
2. The student will also be able to describe the theory of operation of the clipper circuit or may be required to select the correct responses from a list of possible choices, concerning clipper circuits.

4.9.2 COMPETENCY: **Analyze operation of clamper circuit**

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to calculate voltage across each component, and the current through each component, in a clamper circuit, when given sufficient information from which to extract the necessary data.
2. The student will also be able to describe the theory of operation of clamper circuits or may be required to select the correct responses from a list of possible choices, concerning clamper circuits.

4.9.3 COMPETENCY: **Analyze operation of peak detector circuit**

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to calculate voltage across each component, and the current through each component, in a peak detector circuit, when given sufficient information from which to extract the necessary data.

2. The student will also be able to describe the theory of operation of peak detector circuits or may be required to select the correct responses from a list of possible choices, concerning peak detector circuits.

4.9.4 COMPETENCY: **Analyze operation of limiter circuit**

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to calculate voltage across each component, and the current through each component, in a limiter circuit, when given sufficient information from which to extract the necessary data.
2. The student will also be able to describe the theory of operation of limiter circuits or may be required to select the correct responses from a list of possible choices, concerning limiter circuits.

4.9.5 COMPETENCY: **Analyze operation of voltage multiplier circuit**

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to calculate voltage across each component, and the current through each component, in a voltage multiplier circuit, when given sufficient information from which to extract the necessary data.
2. The student will also be able to describe the theory of operation of voltage multiplier circuits or may be required to select the correct responses from a list of possible choices, concerning voltage multiplier circuits.

TASKS
PERFORMANCE OBJECTIVES
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AND
ENABLING OBJECTIVES

4.10 TASK: Calculate Voltage Regulation in Power Supplies

TERMINAL PERFORMANCE OBJECTIVE

1. **Calculate the percentage of voltage regulation for a power supply.**

COMPETENCIES AND EO'S

4.10.1 COMPETENCY: **Calculate no-load voltage**

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to calculate the no-load voltage of a power supply, with no load resistor connected to the supply in question.

4.10.2 COMPETENCY: **Calculate full-load voltage**

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to calculate the output voltage of a power supply, with a resistive load connected in parallel with the output of the supply.

4.10.3 COMPETENCY: **Calculate percent regulation of supply**

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to calculate the percentage of voltage regulation for a power supply, when given the necessary values for no-load voltage, and full-load voltage, or may be required to select the correct responses from a list of possible choices, concerning voltage regulation.
2. The student will be able to calculate the percentage of voltage regulation for a power supply, when required to calculate the necessary values for no-load voltage, and full-load voltage.

TASKS
PERFORMANCE OBJECTIVES
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AND
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4.11 TASK: Compare Characteristics of the Perfect Zener Diode to the Practical Zener Diode

TERMINAL PERFORMANCE OBJECTIVE

1. **Make a comparison of the perfect zener diode to the actual zener diode, in terms of reverse bias current.**
2. **Make a comparison of the perfect zener diode to the actual zener diode, in terms of breakdown voltage.**
3. **Make a comparison of the perfect zener diode to the actual zener diode, in terms of reverse saturation current.**

COMPETENCIES AND EPO'S

4.11.1 COMPETENCY: **Compare reverse bias current in ideal diode vs. actual diode**

ENABLING PERFORMANCE OBJECTIVE

1. The student will make a comparison of the ideal zener diode and the actual zener diode, in terms of reverse bias current, using the characteristic curve for the diode as a source of information.

4.11.2 COMPETENCY: **Compare breakdown voltage in ideal diode vs. actual diode**

ENABLING PERFORMANCE OBJECTIVE

1. The student will make a comparison of the ideal zener diode and the actual zener diode, in terms of breakdown voltage, using the characteristic curve for the diode as a source of information.

4.11.3 COMPETENCY: **Compare reverse saturation current in ideal vs. actual diode**

ENABLING PERFORMANCE OBJECTIVE

1. The student will make a comparison of the ideal zener diode and the actual zener diode, in terms of reverse saturation current, using the characteristic curve for the diode as a source of information.

TASKS
PERFORMANCE OBJECTIVES
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AND
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4.12 TASK: Calculating Component Values in Zener Regulator Circuits

TERMINAL PERFORMANCE OBJECTIVE

1. **Calculate the voltage drop across each component in the zener regulator circuit, and the current flow through each component in the circuit.**
2. **Calculate the correct sizes for the components in the zener regulator circuit.**

COMPETENCIES AND EPO'S

4.12.1 COMPETENCY: **Calculate circuit voltage and current in zener diode regulator circuits**

ENABLING PERFORMANCE OBJECTIVE

1. The student will calculate the voltage drops across each component in the zener regulator circuit, and the current flow through each component in the circuit.

4.12.2 COMPETENCY: **Calculate sizes of components used in zener diode regulator circuits**

ENABLING PERFORMANCE OBJECTIVE

1. The student will calculate the correct sizes for the components in the zener regulator circuit, using the information obtained from calculating the voltage and current flow in the circuit.
2. The student will be able to determine the zener voltage, wattage, and current flow, as well as selecting the correct zener diode to perform the job.
3. The student will be able to determine the correct size and wattage rating of the resistors and other components in the zener regulator.

TASKS
PERFORMANCE OBJECTIVES
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AND
ENABLING OBJECTIVES

4.13 TASK: Describe the Structure and Characteristics of the Bipolar Junction Transistor

TERMINAL PERFORMANCE OBJECTIVE

1. Describe the elements of structure of the typical bipolar transistor and explain how it works.
2. Draw a graph of V_{CE} versus I_C, for a bipolar transistor, for 5 different values of base current.
3. Calculate the value of alpha and beta for the bipolar transistor from circuit values of current flow.
4. Calculate the value of beta (both DC and AC) for the bipolar transistor from values of current and voltage in the circuit, when connected as a common emitter amplifier.
5. Calculate the value of alpha for the bipolar transistor from values of current and voltage in the circuit, when connected as a common base amplifier.
6. Calculate the value of r'e, r'b, and r'c from circuit values of current and voltage, and/or a graph.

COMPETENCIES AND EPO'S

4.13.1 COMPETENCY: Describe elements of structure of transistor

ENABLING PERFORMANCE OBJECTIVE

1. The student will describe the elements of structure of the typical bipolar transistor, and explain how it works, or the student may be required to select the correct responses from a list of possible choices, concerning bipolar transistor structure and operation.

4.13.2 COMPETENCY: Draw characteristic curve

ENABLING PERFORMANCE OBJECTIVE

1. The student will draw and interpret, a graph of V_{CE} and I_C, for a bipolar transistor, for 5 different values of base current. Values selected for base current will be equally spaced, such as 10 uA, 20 uA, 30 uA, 40 uA, and 50 uA. The instructor will determine actual values necessary, based on the type of transistor under test.

4.13.3 COMPETENCY: **Calculate value of alpha from characteristic curve**

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to calculate the value of alpha for the bipolar transistor from data obtained from the characteristic curve for the transistor.

4.13.4 COMPETENCY: **Calculate value of beta from characteristic curve**

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to calculate the value of beta for the bipolar transistor from data obtained from the characteristic curve of the transistor under consideration.

4.13.5 COMPETENCY: **Calculate value of alpha from circuit values**

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to calculate the value of alpha (both DC and AC) for the bipolar transistor from circuit values of current and voltage in the circuit, when connected as a common base amplifier.

4.13.6 COMPETENCY: **Calculate value of beta from circuit values**

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to calculate the value of beta (both DC and AC) for the bipolar transistor, from circuit values of current and voltage in the circuit, when connected as a common emitter amplifier.

TASKS
PERFORMANCE OBJECTIVES
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4.14 TASK: Determine and Describe Breakdown Conditions and Leakage Currents for Bipolar Transistors

TERMINAL PERFORMANCE OBJECTIVE

1. **Describe the conditions surrounding the measurement and calculation of collector to base leakage current, collector to emitter leakage current, collector to emitter breakdown voltage, collector to base breakdown voltage, and emitter to base breakdown voltage.**
2. **Determine the values for the I_{cbo}, I_{ceo}, BV_{ceo}, BV_{cbo}, and BV_{ebo}, from the manufacturers data.**

COMPETENCIES AND EPO'S

4.14.1 COMPETENCY: **Describe conditions for I_{CBO} measurement**

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to describe the conditions surrounding the measurement and calculation of collector to base leakage current.

4.14.2 COMPETENCY: **Determine I_{CBO}**

ENABLING PERFORMANCE OBJECTIVE

1. The student must also be able to determine the value for I_{CBO}, when provided with the manufacturer's data.

4.14.3 COMPETENCY: **Describe conditions for I_{CEO} measurement**

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to describe the conditions surrounding the measurement and calculation of collector to emitter leakage current.

4.14.4 COMPETENCY: **Determine I_{CEO}**

ENABLING PERFORMANCE OBJECTIVE

1. The student must also be able to determine the value for I_{CEO}, when provided with the manufacturer's data.

4.14.5 COMPETENCY: **Describe conditions for BV_{CEO}**

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to describe the conditions surrounding the measurement and calculation of collector to emitter breakdown voltage.

4.14.6 COMPETENCY: **Determine BV_{CEO}**

ENABLING PERFORMANCE OBJECTIVE

1. The student must also be able to determine the value for BV_{CEO}, when provided with the manufacturer's data.

4.14.7 COMPETENCY: **Describe conditions for BV_{CBO}**

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to describe the conditions surrounding the measurement and calculation of collector to base breakdown voltage.

4.14.8 COMPETENCY: **Determine BV_{CBO}**

ENABLING PERFORMANCE OBJECTIVE

1. The student must also be able to determine the value for BV_{CBO}, when provided with the manufacturer's data.

4.14.9 COMPETENCY: **Describe conditions for BV_{EBO} measurement**

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to describe the conditions surrounding the measurement and calculation of emitter to base breakdown voltage.

4.14.10 COMPETENCY: **Determine BV_{EBO}**

ENABLING PERFORMANCE OBJECTIVE

1. The student must also be able to determine the value for BV_{EBO}, when provided with the manufacturer's data.

TASKS
PERFORMANCE OBJECTIVES
COMPETENCIES
AND
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4.15 TASK: Calculate Biasing Component Values, Currents, and Voltages in Bias Circuits

TERMINAL PERFORMANCE OBJECTIVE

1. Calculate the component values, the current through each component, and the voltage drop expected across each component, for a bipolar transistor operated with base bias.
2. Calculate the component values, the current through each component, and the voltage drop expected across each component, for a bipolar transistor operated with voltage divider bias.
3. Calculate the component values, the current through each component, and the voltage drop expected across each component, for a bipolar transistor operated with two supply bias.
4. Calculate the component values, the current through each component, and the voltage drop expected across each component, for a bipolar transistor operated with collector feedback bias.

COMPETENCIES AND EPO'S

4.15.1 COMPETENCY: Calculate base resistor for base bias

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to extract the necessary data concerning the operation of a bipolar transistor circuit, from the characteristic curve, in order to calculate the value of base bias resistor, or calculate the value of base resistor when given the value of emitter voltage, and the value of base current and supply voltage, for base bias.

4.15.2 COMPETENCY: Calculate emitter resistor for any bias arrangement

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to extract the necessary data from various sources, concerning the operation of a bipolar transistor circuit, in order to calculate the value of emitter resistor, when given the voltage drop expected across the emitter resistor, and the current through the emitter resistor, for base bias, voltage divider bias, two supply bias, and collector feedback bias.

4.15.3 COMPETENCY: **Calculate base resistor for collector feedback bias**

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to extract the necessary data from various sources, concerning the operation of a bipolar transistor circuit, in order to calculate the value of base resistor, when given the necessary information to determine power supply voltage, voltage drop across the collector resistor, base current, and emitter voltage, for collector feedback bias.

4.15.4 COMPETENCY: **Calculate collector resistor for any bias arrangement**

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to extract the necessary data from the characteristic curve, or other manufacturer's data, concerning the operation of a bipolar transistor circuit, in order to calculate the value of collector resistor, when given the value of power supply voltage, and the emitter voltage, for base bias, voltage divider bias, two supply bias, and collector feedback bias.

4.15.5 COMPETENCY: **Calculate value of resistor to ground in voltage divider bias circuit**

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to extract the necessary data concerning the operation of a bipolar transistor circuit, in order to calculate the value of R2 (resistor to ground), in a stiff voltage divider, or firm voltage divider bias circuit.

4.15.6 COMPETENCY: **Calculate base to ground voltage in voltage divider bias circuit**

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to extract the necessary data concerning the operation of a bipolar transistor circuit, in order to calculate the voltage from base to ground, when given the emitter voltage, the type of transistor (silicon or germanium), and/or the necessary information to determine these quantities, for voltage divider bias.

4.15.7 COMPETENCY: **Calculate voltage drop across base resistor in voltage divider bias circuit**

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to extract the necessary data concerning the operation of a bipolar transistor circuit, in order to calculate the voltage across base resistor (R1 resistor returned to power supply), when

given the power supply voltage, the base to ground voltage, and/or sizes of R1 and R2 resistors in the voltage divider, or sufficient information to determine these quantities, for voltage divider bias.

4.15.8 COMPETENCY: **Calculate base resistor in voltage divider bias circuit**

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to extract the necessary data concerning the operation of a bipolar transistor circuit, in order to calculate the value of base resistor (R1 resistor returned to power supply), when given the value of R2 (resistor returned to ground), voltage across R1, and voltage from base to ground, or necessary information to determine these values, for voltage divider bias.

4.15.9 COMPETENCY: **Calculate wattage rating of all components in the transistor circuit**

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to extract the necessary data concerning the operation of a bipolar transistor circuit, in order to calculate the wattage rating necessary for all components, including all resistors, the transistor, any diodes or thermistors, and any other components, such as transformers, for base bias, voltage divider bias, two supply bias, and collector feedback bias.

4.15.10 COMPETENCY: **Calculate values of components for two supply bias circuit**

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to extract the necessary data concerning the operation of a bipolar transistor circuit, in order to calculate the component values, the current through each component, and the voltage drop expected across each component, for two supply bias, when given the value of the positive supply and the value of negative supply.

4.15.11 COMPETENCY: **Calculate circuit values for voltage divider bias circuits**

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to extract the necessary data concerning the operation of a bipolar transistor circuit, in order to calculate the current through each component, and the voltage drop expected across each component, for voltage divider bias.

4.15.12 COMPETENCY: Calculate circuit values for base bias circuits

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to extract the necessary data concerning the operation of a bipolar transistor circuit, in order to calculate the current through each component, and the voltage drop expected across each component, for base bias.

4.15.13 COMPETENCY: Calculate circuit values for collector feedback bias

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to extract the necessary data concerning the operation of a bipolar transistor circuit, in order to calculate the current through each component, and the voltage drop expected across each component, for collector feedback bias.

TASKS
PERFORMANCE OBJECTIVES
COMPETENCIES
AND
ENABLING OBJECTIVES

4.16 TASK: Describe the Operation of Interstage Coupling Circuits

TERMINAL PERFORMANCE OBJECTIVE

1. **Describe the theory of operation of the interstage coupling circuits; including RC coupling, impedance coupling, transformer coupling, and DC coupling.**
2. **Calculate circuit values necessary to insure proper coupling of signals from one stage to the next for each of the coupling methods.**

COMPETENCIES AND EPO'S

4.16.1 COMPETENCY: **Theory of operation of RC coupling**

ENABLING PERFORMANCE OBJECTIVE

1. The student will describe the theory of operation of RC coupling, or the student may be required to select the correct responses from a list of possible choices concerning coupling of signals from stage to stage.

4.15.2 COMPETENCY: **Theory of operation of impedance coupling**

ENABLING PERFORMANCE OBJECTIVE

1. The student will describe the theory of operation of impedance coupling, or the student may be required to select the correct responses from a list of possible choices concerning coupling of signals from stage to stage.

4.16.3 COMPETENCY: **Theory of operation of transformer coupling**

ENABLING PERFORMANCE OBJECTIVE

1. The student will describe the theory of operation of transformer coupling, or the student may be required to select the correct responses from a list of possible choices concerning coupling of signals from stage to stage.

4.16.4 COMPETENCY: **Theory of operation of DC coupling**

ENABLING PERFORMANCE OBJECTIVE

1. The student will describe the theory of operation of DC coupling, or the student may be required to select the correct responses from a list of possible choices concerning coupling of signals from stage to stage.

4.16.5 COMPETENCY: **Advantages and disadvantages of each type of coupling method**

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to list one advantage of each of the types of coupling methods.
2. The student will be able to list one disadvantage of each of the types of coupling methods.

4.16.6 COMPETENCY: **Describe factors that determine selection of component values for each type of coupling method**

ENABLING PERFORMANCE OBJECTIVE

1. The student will describe the factors that determine the size of components used in coupling circuits, and show how the size is determined. The student will calculate size of coupling capacitors, decoupling capacitors, impedance and resistance values for coils, and transformers, and any other values necessary to insure that signal is properly transferred from stage to stage, or the student may be required to select the correct responses from a list of possible choices concerning coupling of signals from stage to stage.

TASKS
PERFORMANCE OBJECTIVES
COMPETENCIES
AND
ENABLING OBJECTIVES

4.17 TASK: Identify Effects of External Components on Operation of Bipolar Transistors at Low, Medium, and High Frequency

TERMINAL PERFORMANCE OBJECTIVE

1. **Describe how the operation of the bipolar transistor is affected as the frequency is changed from low to medium to high, as a result of the effects of coupling capacitors, decoupling circuits, stray inductance, stray capacitance, and Miller effect.**
2. **Calculate the approximate values of frequency response of a given amplifier circuit.**

COMPETENCIES AND EPO'S

4.17.1 COMPETENCY: **Describe effect of coupling capacitors**

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to describe the effects of coupling capacitors as the frequency is changed from low to medium to high.

4.17.2 COMPETENCY: **Describe effects of decoupling circuits**

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to describe the effects of decoupling circuits, used to decouple the circuit from the power supply, as the frequency is changed from low to medium to high.

4.17.3 COMPETENCY: **Describe effects of bypass capacitors**

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to describe the effects of bypass capacitors, as the frequency is changed from low to medium to high.

4.17.4 COMPETENCY: **Describe effects of stray L and C**

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to describe the effects of stray capacitance, and inductance, as the frequency is changed from low to medium to high.

4.17.5 COMPETENCY: **Describe Miller effect**

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to describe what Miller effect is, and describe its effects, as the frequency is changed from low to medium to high.

4.17.6 COMPETENCY: **Calculate frequency response of amplifier**

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to calculate the approximate frequency response of a given amplifier circuit, when given the necessary information concerning the operation of the circuit, and determine the effect of the reactive components on the frequency response of the circuit.

TASKS
PERFORMANCE OBJECTIVES
COMPETENCIES
AND
ENABLING OBJECTIVES

4.18 TASK: Analyze Operation of Common Emitter, Common Collector, and Common Base Amplifier at Low, Medium, and High Frequency

TERMINAL PERFORMANCE OBJECTIVE

1. Describe the effect on the Common Emitter amplifier, as the frequency is changed from low to medium to high. 2. Calculate the AC gain, in a Common Emitter amplifier, as the frequency is changed from low to medium to high, using voltage divider bias.
3. Describe the effect on the Common Collector amplifier, as the frequency is changed from low to medium to high.
4. Calculate the AC gain, in a Common Collector amplifier, as the frequency is changed from low to medium to high, using voltage divider bias.
5. Describe the effect on the Common Base amplifier, as the frequency is changed from low to medium to high.
6. Calculate the AC gain, in a Common Base amplifier, as the frequency is changed from low to medium to high, using voltage divider bias.
7. Define 'Gain-Bandwidth-Product', and use F_T to calculate gain of a transistor, as a function of frequency.
8. Describe the effect that interelectrode capacitance has on the frequency response of the circuit, for the three types of hookup. (Common Emitter, Base, and Collector).

COMPETENCIES AND EPO'S

4.18.1 COMPETENCY: **Define interelectrode capacitance**

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to define the term 'interelectrode capacitance', as related to the bipolar transistor, and list typical values of capacitance.

4.18.2 COMPETENCY: **Define Gain Bandwidth Product**

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to define the term 'Gain-Bandwidth-Product', and solve mathematical problems related to F_T. The student will be able to determine the voltage gain, current gain, and power gain of the transistor, at any frequency as determined by the gain-bandwidth-product. Gain will be expressed both as a dimensionless ratio, and as a decibel value.

TASKS
PERFORMANCE OBJECTIVES
COMPETENCIES
AND
ENABLING OBJECTIVES

4.19 TASK: Design Cascaded Amplifier Circuits

TERMINAL PERFORMANCE OBJECTIVE

1. Draw the schematic diagram of a two stage cascaded amplifier circuit, and calculate the values of the components to be used in the circuit, for the common emitter to common emitter, common emitter to common collector, and common base to common emitter cascaded connection.

COMPETENCIES AND EPO'S

4.19.1 COMPETENCY: Calculate circuit values for common emitter to common emitter cascade amp

ENABLING PERFORMANCE OBJECTIVE

1. Given specifications concerning power supply voltage, voltage gain expected, signal voltage input, and expected signal voltage output, the student will draw the schematic diagram of the cascaded amplifier circuit, and calculate the values of the components to be used in the circuit, for the common emitter to common emitter cascaded amplifier circuit.

4.19.2 COMPETENCY: Calculate circuit values for the common emitter to common collector cascade amplifier

ENABLING PERFORMANCE OBJECTIVE

1. Given specifications concerning power supply voltage, voltage gain expected, signal voltage input, and expected signal voltage output, the student will draw the schematic diagram of the cascaded amplifier circuit, and calculate the values of the components to be used in the circuit, for the common emitter to common collector cascaded amplifier circuit.

4.19.3 COMPETENCY: Calculate circuit values for common base to common emitter cascaded amplifier

ENABLING PERFORMANCE OBJECTIVE

1. Given specifications concerning power supply voltage, voltage gain expected, signal voltage input, and expected signal voltage output, the student will draw the schematic diagram of the cascaded amplifier circuit, and calculate the values of the components to be used in the circuit, for the common base to common emitter amplifier circuit.

TASKS
PERFORMANCE OBJECTIVES
COMPETENCIES
AND
ENABLING OBJECTIVES

4.20 TASK: Describe Classes of Bias Used with Transistor Amplifiers

TERMINAL PERFORMANCE OBJECTIVE

1. **Describe the classes of bias, (Class A, AB, B, and C) and explain the reason for the use of each, as well as the advantages and disadvantages of each.**

COMPETENCIES AND EPO'S

4.20.1 COMPETENCY: **Describe class A bias**

ENABLING PERFORMANCE OBJECTIVE

1. The student will describe what class A bias is, and explain the reason for the use of class A bias, as well as the advantages and disadvantages of class A bias.

4.20.2 COMPETENCY: **Describe class B bias**

ENABLING PERFORMANCE OBJECTIVE

1. The student will describe what class B bias is, and explain the reason for the use of class B bias, as well as the advantages and disadvantages of class B bias.

4.20.3 COMPETENCY: **Describe class C bias**

ENABLING PERFORMANCE OBJECTIVE

1. The student will describe what class C bias is, and explain the reason for the use of class C bias, as well as the advantages and disadvantages of class C bias.

4.20.4 COMPETENCY: **Describe class AB bias**

ENABLING PERFORMANCE OBJECTIVE

1. The student will describe what class AB bias is and explain the reason for the use of class AB bias as well as the advantages and disadvantages of class AB bias.

TASKS
PERFORMANCE OBJECTIVES
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AND
ENABLING OBJECTIVES

4.21 TASK: Calculate the Power Consumption of Transistor Amplifiers

TERMINAL PERFORMANCE OBJECTIVES

1. Given the characteristic curves and the schematic diagrams of the circuit under consideration, determine the collector power dissipation for all portions of the active region of operation of the transistor amplifier.
2. Using the characteristic curves for the transistor amplifier stage under consideration, determine the maximum collector power curve and plot it on the characteristic curve.

COMPETENCIES AND EPO'S

4.21 COMPETENCY: **Calculate collector power dissipation**

ENABLING PERFORMANCE OBJECTIVE

1. Given the characteristic curves and the schematic diagrams of the circuit under consideration, the student will be able to determine the collector power dissipation for all portions of the active region of operation of the transistor amplifier.

4.21.2 COMPETENCY: **Plot collector dissipation curve on transistor characteristic curve**

ENABLING PERFORMANCE OBJECTIVE

1. Using the characteristic curves for the transistor amplifier stage under consideration, the student will be able to determine the maximum collector power curve and plot it on the characteristic curve.

TASKS
PERFORMANCE OBJECTIVES
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AND
ENABLING OBJECTIVES

4.22 TASK: Describe the Structure and Characteristics of Field Effect Transistor Devices

TERMINAL PERFORMANCE OBJECTIVE

1. Describe how N channel and P channel JFET transistors are constructed, and explain how they operate.
2. Describe how depletion mode N channel and P channel MOSFET transistors are constructed, and explain how they operate.
3. Describe how the enhancement mode N channel and P channel MOSFET transistors are constructed, and explain how they operate.

COMPETENCIES AND EPO'S

4.22.1 COMPETENCY: Theory of operation JFET transistor

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to describe how the N channel and P channel FET transistors are constructed, and explain how they operate.

4.22.2 COMPETENCY: Theory of operation depletion mode MOSFET transistors

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to describe how the depletion mode N channel and P channel MOSFET transistors are constructed, and explain how they operate.

4.22.3 COMPETENCY: Theory of operation enhancement mode MOSFET transistors

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to describe how the enhancement mode N channel and P channel MOSFET transistors are constructed, and explain how they operate.

TASKS
PERFORMANCE OBJECTIVES
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AND
ENABLING OBJECTIVES

4.23 TASK: Draw the Drain Characteristic Curves for the FET Transistor

TERMINAL PERFORMANCE OBJECTIVE

1. **Draw a graph of the FET drain characteristics.**
2. **Calculate the drain saturation current and pinch off voltage.**
3. **Calculate the value for transconductance.**
4. **Determine the value of the shorted gate drain current for a given FET transistor.**

COMPETENCIES AND EPO'S

4.23 COMPETENCY: **Draw a drain characteristic curve**

ENABLING PERFORMANCE OBJECTIVE

1. Given the necessary values of gate voltage, drain current, and gate to source voltage, the student will be able to draw a graph of the FET drain characteristics.

4.23.2 COMPETENCY: **Determine drain saturation current, pinch-off voltage for FET**

ENABLING PERFORMANCE OBJECTIVE

1. Using information obtained from the graph, the student will be able to calculate the drain saturation current and pinch off voltage for the FET device under consideration.

4.23.3 COMPETENCY: **Calculate transconductance**

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to calculate the value for transconductance, by using information obtained from circuit values, and/or values obtained from the characteristic curves for the FET transistor under consideration.

4.23.4 COMPETENCY: **Determine shorted gate drain current**

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to determine the value of the shorted gate drain current for a given FET transistor, when given the drain characteristic curves for the device.

TASKS
PERFORMANCE OBJECTIVES
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AND
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4.24 TASK: Describe Biasing Conditions for JFET Devices

TERMINAL PERFORMANCE OBJECTIVE

1. **Calculate the correct values for voltage and current in the JFET transistor circuit to produce the proper conditions for the various classes of bias possible for the JFET.**
2. **Sketch the DC load line for the device; calculate the voltages and currents in the circuit; and calculate the value of components to be used.**
3. **Sketch the AC load line for the device.**
4. **Describe the four types of biasing arrangements for the FET transistor circuit**

COMPETENCIES AND EPO'S

4.24.1 COMPETENCY: **Calculate conditions for bias of JFET amp**

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to calculate the correct values for voltage and current in the JFET transistor circuit to produce the proper conditions for the various classes of bias possible for the JFET.

4.24.2 COMPETENCY: **Sketch DC load line for FET amp**

ENABLING PERFORMANCE OBJECTIVE

1. Given the characteristic curves for the FET device under consideration, as well as necessary manufacturer's data, the student will be able to sketch the DC load line for the device.
2. The student will be able to calculate the voltages and currents in the circuit, as well as the value of components to be used.

4.24.3 COMPETENCY: **Sketch AC load line for FET amp**

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to sketch the AC load line, when given the values of the components in the circuit, and show how the AC load line varies from the DC load line.

4.24.4 COMPETENCY: **Describe operation of FET with self bias**

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to describe the operation of self bias type of biasing arrangement for the FET transistor circuit.

4.24.5 COMPETENCY: **Describe operation of FET with current source bias**

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to describe the operation of current source bias type of biasing arrangement for the FET transistor circuit.

4.24.6 COMPETENCY: **Describe operation of FET with zero bias**

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to describe the operation of zero bias type of biasing arrangement for the FET transistor circuit.

4.24.7 COMPETENCY: **Describe operation of FET with drain feedback bias**

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to describe the operation of drain feedback bias type of biasing arrangements for the FET transistor circuit.

TASKS
PERFORMANCE OBJECTIVES
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AND
ENABLING OBJECTIVES

4.25 TASK: Describe and Calculate Operation of the FET Device Under Varying Frequency Conditions

TERMINAL PERFORMANCE OBJECTIVE

1. Describe the theory of operation for the FET device under DC, low frequency, medium frequency, and high frequency conditions, and list the components that cause the effects noted in the FET amplifier.
2. Describe the operation of the Source Follower, Single Stage Inverting Amplifier, and the Common Gate Amplifier, in terms of frequency response and usage at low, medium, and high signal frequencies.
3. Calculate the stage gain of the FET amplifier circuit.
4. Calculate the frequency response of the FET amplifier circuit.

COMPETENCIES AND EPO'S

4.25.1 COMPETENCY: Describe how FET circuit is affected by frequency

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to describe the theory of operation for the FET device under DC, low frequency, medium frequency, and high frequency conditions.

4.25.2 COMPETENCY: List components affecting frequency response

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to list the components that cause the effects noted in the FET amplifier.

4.25.3 COMPETENCY: Compare source follower, inverting amp, and common gate amp frequency response

ENABLING PERFORMANCE OBJECTIVE

1. The student will discuss the operation of the Source Follower, Single Stage Inverting Amplifier, and the Common Gate Amplifier, in terms of frequency response and usage at low, medium, and high signal frequencies.

TASKS
PERFORMANCE OBJECTIVES
COMPETENCIES
AND
ENABLING OBJECTIVES

4.26 TASK: Identify Hybrid Parameters for Bipolar Transistors

TERMINAL PERFORMANCE OBJECTIVE

1. Identify the H and R hybrid parameters for the bipolar transistor.
2. Compare the H and R parameters and discuss measurement methods.

COMPETENCIES AND EPO'S

4.26.1 COMPETENCY: Define $h_{r\infty}$ and show how it is measured

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to define the term $h_{r\infty}$, and show the conditions necessary to measure $h_{r\infty}$.
2. The student will be able to write and use the formula for calculating $h_{r\infty}$.

4.26.2 COMPETENCY: Define $h_{i\infty}$ and show how it is measured

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to define the term $h_{i\infty}$, and show the conditions necessary to measure $h_{i\infty}$.
2. The student will be able to write and use the formula for calculating $h_{i\infty}$.

4.26.3 COMPETENCY: Define $h_{f\infty}$ and show how it is measured

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to define the term $h_{f\infty}$, and show the conditions necessary to measure $h_{f\infty}$.
2. The student will be able to write and use the formula for calculaing $h_{f\infty}$.

4.26.4 COMPETENCY Define $h_{o\infty}$ and show how it is measured

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to define the term $h_{o\infty}$, and show the conditions necessary to measure $h_{o\infty}$.
2. The student will be able to write and use the formula for calculating $h_{o\infty}$.

4.26.5 COMPETENCY **Define beta and show relationship to H parameters**

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to define the term beta, and show the relationship between beta, and the H parameter h_{fe}.

4.26.6 COMPETENCY: **Define alpha and show relationship to H parameters**

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to define the term alpha and show the relationship between alpha and the h parameter h_{fe}.

4.26.7 COMPETENCY: **Define r'_e and show relationship to H parameters**

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to define the term r'_e and show the relationship between r'_e and the h parameters h_{fe} and h_{oe}.

4.26.8 COMPETENCY: **Define r'_c and show relationship to H parameters**

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to define the term r'_c and show the relationship between r'_c and the h parameters h_{fe} and h_{oe}.

4.26.9 COMPETENCY: **Define r'_b and show relationship to H parameters**

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to define the term r'_b and show the relationship between r'_b and the h parameters h_{rb} and h_{ob}.

4.26.10 COMPETENCY: **Calculate gain and impedance using H parameters**

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to calculate voltage gain, current gain, input impedance, and output impedance by using h parameters.

TASKS
PERFORMANCE OBJECTIVES
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AND
ENABLING OBJECTIVES

4.27 TASK: Compare Hybrid Parameters of Bipolar Transistors to Conditions Found in the FET circuit

TERMINAL PERFORMANCE OBJECTIVE

1. **Compare the hybrid parameters of the bipolar transistor to the conditions associated with the FET transistor, and recognize values for the corresponding H and R parameters.**

COMPETENCIES AND EPO'S

4.27.1 COMPETENCY: **Compare h_{fe} in bipolar transistors to corresponding quantities in FET's.**

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to make a comparison between the FET type transistor operating conditions, and compare values for h_{fe} (Beta) with values measured in the FET circuit.

4.27.2 COMPETENCY: **Compare h_{ie} in bipolar transistors to corresponding quantities in FET's**

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to make a comparison between the FET type transistor operating conditions, and compare values for h_{ie} with values measured in the FET circuit.

4.27.3 COMPETENCY: **Compare h_{re} in bipolar transistors to corresponding quantities in FET's**

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to make a comparison between the FET type transistor operating conditions, and compare values for h_{re} (Beta) with values measured in the FET circuit.

4.27.4 COMPETENCY: **Compare h_{oe} in bipolar transistors to corresponding quantities in FET's**

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to make a comparison between the FET type transistor operating conditions, and compare values for h_{oe} (Beta) with values measured in the FET circuit.

4.27.5 COMPETENCY: **Compare alpha in bipolar transistors to corresponding quantities in FET's**

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to make a comparison between the FET type transistor operating conditions, and compare values for alpha with values measured in the FET circuit.

4.27.6 **Compare r'_e in bipolar transistors to corresponding quantities in FET's**

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to make a comparison between the FET type transistor operating conditions, and compare values for r'_e with values measured in the FET circuit.

4.27.7 COMPETENCY: **Compare r'_c in bipolar transistors to corresponding quantities in FET's**

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to make a comparison between the FET type transistor operating conditions, and compare values for r'_c with values measured in the FET circuit.

4.27.8 COMPETENCY: **Compare r'_b in bipolar transistors to corresponding quantities in FET's.**

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to make a comparison between the FET type transistor operating conditions, and compare values for r'_b with values measured in the FET circuit.

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4.18.3 COMPETENCY: **Analyze effects of frequency on CE amplifier**

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to analyze the effect of changing frequency on the Common Emitter amplifier, with voltage divider bias. Student will calculate the voltage, current, and power gain of a given transistor circuit at low, medium, and high frequency. Circuit to be used, and the frequencies to be considered will be determined by the instructor. However, each circuit should contain the same transistor, and use the same bias arrangement, so the student can make comparison between the three types of hookup, without introducing too many other variables.

4.18.4 COMPETENCY: **Analyze effects of frequency on CC amplifier**

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to analyze the effect of changing frequency on the Common Collector amplifier, with voltage divider bias. The student will calculate the voltage, current, and power gain of a given transistor circuit at low, medium, and high frequency. Circuit to be used, and the frequencies to be considered will be determined by the instructor. However, each circuit should contain the same transistor, and use the same bias arrangement, so the student can make comparison between the three types of hookup, without introducing too many other variables.

4.18.5 COMPETENCY: **Analyze effects of frequency on CB amplifier**

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to analyze the effect of changing frequency on the Common Base amplifier, with voltage divider bias. The student will calculate the voltage, current, and power gain of a given transistor circuit at low, medium, and high frequency. Circuit to be used, and the frequencies to be considered will be determined by the instructor. However, each circuit should contain the same transistor, and use the same bias arrangement, so the student can make comparison between the three types of hookup, without introducing too many other variables.

4.25.4 COMPETENCY: **Calculate stage gain**

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to calculate the stage gain of the FET amplifier circuit, when given the drain characteristic curves and the schematic diagram of the FET amplifier circuit to be considered.

4.25.5 COMPETENCY: **Calculate frequency response**

ENABLING PERFORMANCE OBJECTIVE

1. The student will be able to calculate the frequency response of the FET amplifier circuit, when given the drain characteristic curves and the schematic diagram for FET circuit to be considered.